Journal of the
Ocean Science Foundation

2009, Vol. 2

A quantitative assessment of reef fish distribution and abundance within near-shore reef habitats of Yap State, F. S. M.

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Abstract

We quantified the distribution and abundance of reef fishes at nine sites around the islands of Yap Proper, Micronesia. These sites were chosen on the basis of location, habitat type, and level of human impact. During more than 158 hours of monitoring effort we encountered a total of 346 species representing 51 families. Of these fish, 114 had not been previously reported for Yap, though many were expected given their biogeographic distributions elsewhere. Herbivorous fishes (e.g., Acanthuridae, Scaridae, Pomacentridae) were the dominant groups, with densities of the Bristletooth Surgeonfish *Ctenochaetus striatus* (Quoy & Gaimard, 1825) and the Bullethead Parrotfish, *Chlorurus sordidus* (Forsskål, 1775) ranging from 25 - 50 fish/100 m^2 in most locations. The Moorish Idol, *Zanclus cornutus* (Linnaeus, 1758), Convict Surgeonfish, *Acanthurus triostegus* (Linnaeus, 1758) and Bluehead Wrasse, *Thalassoma amblycephalum* (Bleeker, 1856) were also notably abundant. Diverse (27 species) and abundant populations of butterflyfishes (Chaeteodontodae; often considered as "indicator species" for reef health) were encountered at all sites.

Key words: coral reef, fish, biodiversity, monitoring, Micronesia, Yap

Introduction

Island populations rely heavily upon their surrounding marine resources for food and other commodities. This is particularly true in isolated regions, where 10 to 50 kg of fish may supply up to 75% of an individual's total annual animal protein consumption (Nelson, 1989). Under such conditions, knowledge about the availability and use of various marine species is obviously critical to their successful management and conservation. Nowhere is this more evident than among the islands of Micronesia, a relatively isolated archipelago whose inhabitants have traditionally replied upon the ocean for a majority of their resources (e.g. Johannes 1981; Lobban & Schefter 1997; Tafileichig & Inoue 2001)

The reefs of Micronesia support rich and abundant fish communities, in part because of their proximity to the Indo-west Pacific faunal zone, a region of maximal marine biodiversity (Colin & Arenson 1997, Myers 1999). Over 1,300 species of near-shore fishes are reported for Micronesia (including Palau, all estimates of diversity from Myers, 1999), a level indicative of the archipelago's intermediate position between the high diversity reefs of the southern Philippines/eastern Indonesia region (~ 2500 spp) and the much less diverse reef-fish

assemblies of the more easterly Pacific Plate (200 – 400 spp). Within the region, there is a general decline in species richness from Palau in the west, through the Caroline Islands, and on to the Marshalls (Myers 1999).

The isolated nature of Micronesian reefs, with their relatively small island populations and associated lower levels of fishing pressure, has presumably helped maintain the region's bountiful reef communities. Traditional practices of reef ownership and local oversight of fishing rights at specific locations and times has also contributed to a largely sustainable relationship between island inhabitants and marine resources (Tafileichig & Inoue 2001). Increasingly, however, such traditional approaches are being abandoned or circumvented in favor of modern, more exploitive practices that support both a growing island population and the increasing demand for the commercial export of targeted species.

The impacts of these changes are unknown. Beyond basic surveys of occurrence, there are few data on even the most basic patterns of regional distribution and abundance of marine fishes around islands in the region, particularly Yap and Kosrae (reviewed in Myers 1999). The relevance of these data to issues of reef conservation and management highlight the need to develop monitoring protocols that can be implemented on a regular basis to facilitate stock assessment. To this end, we quantified reef fish distributions and abundances within fore-reef, back-reef, and channel habitats of Yap State, F.S.M. The results of those surveys are summarized here.

Materials and Methods

Study sites. In consultation with Yap State's Marine Resources and Management Division (MRMD; A. Tafileichig, pers. comm.), we chose nine sites (Table 1) for monitoring within the reef complex of Yap Proper (Figure 1). These sites were chosen on the basis of three main criteria: 1) Geographic location (we sought an array of sites dispersed around Yap Proper with varied orientations to the open sea); 2) Habitat type (e.g., fore-reef, back-reef, or channel) and 3) Degree of human activity (sites such as Goofnuw and Mi'l channels are, seasonally, extremely popular diving destinations because of aggregations of manta rays (Manta birostris). Fore-reef sites such as Peelaek, Barge and the South reefs are visited more intermittently). Sites were also selected with an eye to their suitability for repeated surveys on future dates. Because of their ecological similarity and proximity (~70 m), data from the two sites at Yyin were lumped for this study. The latitude and longitude of each site was obtained from an average of three GPS readings at the point of anchor.

Table 1. Study site locations, habitat types, and survey sample sizes. See text for details.

					Survey type		
	Site	**Lat.**	**Lon.**	**Habitat**	**Random**	**Stationary**	**Transect**
	Yyin A	9° 35.54'	138° 7.12'	Back-reef	8	8	24
West Reefs	Yyin B	9° 35.54'	138° 7.21'	Back-reef	5	10	22
	Miil Channel	9° 35.91'	138° 7.58'	Channel	14	4	28
North Reefs	North	9° 37.57'	138° 10.10'	Back-reef	14	8	36
	Goofnuw	9° 33.97'	138° 12.16'	Channel	6	10	23
East Reefs	Peelaek	9° 29.83'	138° 9.68'	Fore-reef	8	5	16
	Tomil A	9° 30.24'	138° 8.71'	Back-reef	5	7	30
	Barge	9° 29.63'	138° 9.07'	Fore-reef	7	3	12
South Reefs	South	9° 25.18'	138° 2.02'	Fore-reef	13	2	10

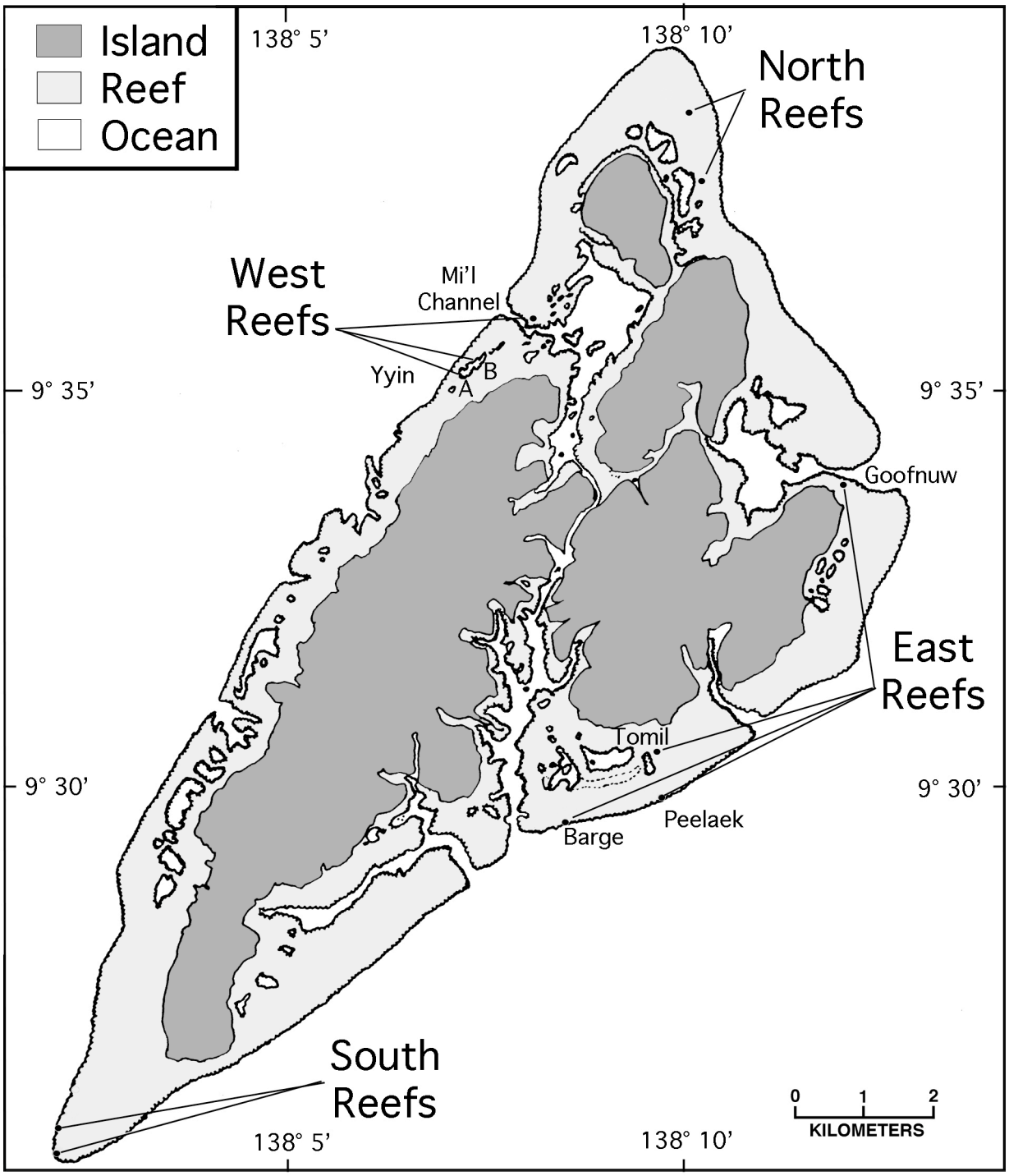

FIGURE 1. A map of study site locations within the reef complex of Yap Proper. See Table 1 for additional site details.

We assessed the benthic community at each site by noting the percent cover within either 1 m^2 or 0.25 m^2 quadrats made of weighted PVC plastic. Cover categories included: Live coral, sand, algal turf, coralline red algae, macro-algae (originally recorded as green, brown, or red, but lumped for this study), cyanobacteria, and "bare substrate" (no obvious cover on hard, non-living substrate). Individual corals and macro-algae were counted and identified to lowest possible taxonomic level. Water depth was also recorded. We chose quadrat location within a specific site by haphazardly dropping or tossing the quadrat into the habitat, with a minimum of 20 quadrat measurements collected for each site.

Survey Protocols. A team of eleven observers conducted these surveys during a twelve-day period in early 2002 (3/28/02 - 4/9/02). These observers were trained in both fish identification and survey methodology during an intensive five-week training period in Guam and Palau (overseen by KEC). Identifications were confirmed using Myers (1999). All surveys occurred between 09:00 and 15:00.

Surveys may provide information on occurrence, distribution, relative abundance, and/or absolute abundance. Measures of occurrence and distribution (i.e., whether a species is encountered at a particular location) are generally the easiest surveys to undertake, while measures of absolute abundance (density) are typically the most time consuming (they include a spatial dimension within the survey protocol lacking in simple measures of occurrence).

Following Clifton & Clifton (1998), we adapted three basic survey methods to the current study: Timed Swims, Stationary Counts and Transect Surveys. All data were collected using snorkel gear, with observations recorded on plexiglass slates or underwater paper.

Timed Counts: Timed fish counts were developed under the principle that abundant species have a higher probability of encounter than do less common species. Through time, we would thus expect to encounter common species earlier than less common species. As such, these surveys provide information on species richness and relative abundance, but not absolute abundance. They have the advantage of being simple to perform, with a minimum of equipment. They also increase the likelihood of encountering less common species (at least relative to methods that include a spatial measure. See below).

For the present study, observers recorded fish sightings during a twenty-five minute interval. Each count was done within a proscribed depth range and habitat type (fore-reef, back-reef, or channel), beginning at an arbitrary point. The twenty-five minute observational period was broken into five-minute intervals. The initial sighting of each species was scored according to the interval in which it was seen. Species seen for the first time in the first five minutes received a 5, those seen during the second five minutes received a 4, and so on down to a score of 1 for species seen for the first time during the final five minutes of the count. Fish not seen within a 25 minute swim received no score.

For data analysis, each species received an average score according to either habitat type or location. We calculated relative abundance scores by multiplying the average score by the proportion of surveys in which the species received a score (e.g. a fish that was observed twice during a total of five surveys, once in the first five minutes (score=5) and once in the second five minutes (score=4), it would receive a score of (5+4)/2=4.5. Using the proportion of surveys observed (2/5=0.4), we multiplied it by the average (4.5) and received an abundance score (1.8). When ties occurred between relative abundance scores within habitat type, we ranked them ordinally. We derived the proportional rank by using the formula: (total # of species-rank)/(total # of species-1), which allowed us to compare the generated ranks between different habitat types or locations).

Stationary Counts: We used stationary counts to collect additional data on species richness, abundance and density at each site. Stationary counts are particularly appropriate for uniformly dispersed, sedentary and cryptic species but less well suited for patchily distributed or highly mobile species. For the present study, we counted the number of fish of each species present or passing through a "cylinder" (2.5 m radius) extending up through the water column. Because the majority of species counted with this method were associated with the benthos, densities were calculated by dividing the total number of a species by the area of substrate covered (i.e. the "bottom" of the cylinder, ~ 20 m^2) to yield estimates of number of fish/m^2.

Stationary counts were conducted during a twenty-minute period using the following timeline. In the first fifteen minutes of observation time we recorded the number of all fish species occurring within the "cylinder". This was done by slowly rotating within the cylinder or by observing from above. We tried to avoid counting the same fish twice by making repeated counts for sedentary species. During the last five minutes of each observation period a more thorough search was conducted in order to better detect small or cryptic species.

Transect surveys: Like stationary counts, transect surveys generate estimates of absolute abundance by providing information on density. For fish, transects work particularly well for large, motile species. As we were interested in the potential effects of fishing, we focused our transect efforts on families of fish that were targeted by fishermen (Table 4). Although not typically taken by fishermen, we also counted all species of butterflyfishes. We conducted each survey by swimming slowly along a 50 meter transect (mean time of swim ± 1 SE = 8.2 ± 0.34 min) and counting all fish of the target species that occurred in front of and on either side of the swimmer within 2 meters of the transect tape (100 m^2 total area) and densities were calculated as number of fish/100m^2.

Benthic community structure. We characterized the benthic community at each site by estimating the percentage cover of 10 substrate categories within 1 m^2 quadrats (live coral, sand, bare substrate, coralline red, macro algae, sea grass, turf, cyanobacteria, and "other" invertebrates). Species identifications were made when possible, but are not included here. Overall, we surveyed only shallow water (0 -10 m), reef-associated habitats.

Results

We encountered a total of 346 species, representing 51 families during our surveys (Table 3). 114 of these had not been previously recorded from Yap (Myers 1999). We did not observe 164 species noted in Myers (1999) as occurring in Yap. Live coral cover at survey locations ranged from 7.5 to 36.3 percent at depths of 1 – 3 m. (Table 2).

Table 2. Percent cover of benthic community at eight study sites in around Yap Proper. Habitat type: BR = Back-reef; FR = Fore-reef; CH = Channel. Sample sizes in parentheses. See Figure 1 for site locations.

	Yyin BR (90)	Miil Ch. CH (30)	North BR (29)	Goofnuw CH (52)	Tomil BR (39)	Peelaek FR (20)	Barge FR (24)	South FR (20)
Depth (m; mean ± 1 SE)	1.6 ± 0.1	2.7 ± 0.2	1.1 ± 0.1	2.1 ± 0.2	1.5 ± 0.1	2.9 ± 0.2	2.8 ± 0.1	3.0 ± 0.2
% Live Coral Cover	19.6%	36.3%	31.5%	35.0%	26.0%	12.5%	7.5%	22.9%
Macroalgae	14.1%	5.7%	15.3%	6.6%	28.8%	19.8%	5.8%	6.0%
Turf	1.3%	15.9%	23.8%	24.0%	33.0%	44.2%	77.8%	50.1%
Cyanobacteria	7.3%	1.6%	0.9%	0.0%	0.3%	0.0%	0.4%	0.0%
Sand	34.9%	35.6%	7.5%	21.7%	10.0%	4.2%	6.4%	1.0%
Bare Substrate	19.2%	2.2%	0.5%	2.1%	0.0%	11.2%	0.7%	7.0%
Coralline Red Algae	3.8%	2.1%	17.6%	10.2%	2.4%	4.1%	1.9%	3.7%

Table 3. A list of 343 species of fish encountered during timed swim surveys of reefs around Yap Proper, FSM. Data for all surveys (Total) are also organized b habitat type. Sample sizes for each group in parentheses. Within each group: N = number of surveys in which the species was encountered; Ave. = Average encounte score; Score = a weighed index of encounter score (see text); Rank = numeric species rank overall, or within a habitat, based on score.

		Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
Family	***Species***	**N**	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**
Acanthuridae (Surgeonfishes)																	
	Acanthurus guttatus (Forster & Schneider, 1801)	4	3.50	0.17	194					4	3.50	0.50	119				
	Acanthurus lineatus (Linnaeus, 1758)	40	4.50	2.22	29	6	4.17	0.76	76	26	4.77	4.43	4	8	3.88	1.55	55
	Acanthurus maculiceps (Ahl, 1923)	1	2.00	0.02	300					1	2.00	0.07	205				
	Acanthurus nigricans (Linnaeus, 1758)	20	4.60	1.14	64	9	4.67	1.27	54	8	4.75	1.36	52	3	4.00	0.60	91
	Acanthurus nigricauda (Dunker & Mohr, 1929)	53	4.02	2.63	16	23	4.17	2.91	22	17	3.47	2.11	32	13	4.46	2.90	22
	Acanthurus nigrofuscus (Forsskål, 1775)	63	4.19	3.26	8	28	4.04	3.42	14	23	4.43	3.64	10	12	4.08	2.45	28
	Acanthurus olivaceus (Forster & Schneider, 1801)	5	3.40	0.21	181					5	3.40	0.61	102				
	Acanthurus pyroferus (Kittlitz, 1834)	6	1.83	0.14	210	5	2.00	0.30	135	1	1.00	0.04	212				
	Acanthurus thompsoni (Fowler, 1923)	2	3.00	0.07	249	2	3.00	0.18	167								
	Acanthurus triostegus (Linnaeus, 1758)	44	3.93	2.14	33	30	3.83	3.48	13	8	4.38	1.25	58	6	3.83	1.15	66
	Acanthurus xanthopterus (Valenciennes, 1835)	10	3.80	0.47	120	4	3.25	0.39	112	6	4.17	0.89	82				
	Ctenochaetus binotatus (Randall, 1955)	2	3.50	0.09	239	2	3.50	0.21	162								
	Ctenochaetus striatus (Quoy & Gaimard, 1825)	80	4.91	4.85	1	33	4.79	4.79	2	28	5.00	5.00	1	19	5.00	4.75	3
	Ctenochaetus strigosus (Bennett, 1828)	1	5.00	0.06	255									1	5.00	0.25	133
	Naso annulatus (Quoy & Gaimard, 1825)	9	3.56	0.40	134	4	3.50	0.42	106	5	3.60	0.64	100				
	Naso brevirostris (Valenciennes, 1835)	9	3.44	0.38	139	3	3.00	0.27	148	4	4.00	0.57	110	2	3.00	0.30	124
	Naso lituratus (Bloch & Schneider, 1801)	58	4.34	3.11	9	22	3.82	2.55	27	24	4.83	4.14	6	12	4.33	2.60	26
	Naso unicornis (Forsskål, 1775)	7	3.86	0.33	146	3	4.00	0.36	120	2	3.50	0.25	161	2	4.00	0.40	112
	Naso vlamingii (Valenciennes, 1835)	12	3.67	0.54	111					9	3.67	1.18	65	3	3.67	0.55	96
	Zebrasoma scopas (Cuvier, 1829)	57	4.19	2.95	12	27	4.11	3.36	15	13	3.85	1.79	40	17	4.59	3.90	12
	Zebrasoma veliferum (Bloch, 1797)	57	3.58	2.52	18	20	3.30	2.00	35	21	3.33	2.50	22	16	4.25	3.40	16
Apogonidae (Cardinalfishes)																	
	Apogon leptacanthus (Bleeker, 1856)	3	4.00	0.15	203	3	4.00	0.36	120								
	Apogon novemfasciatus (Cuvier, 1828)	2	4.00	0.10	228	2	4.00	0.24	159								
	Archamia fucata (Cantor, 1850)	1	1.00	0.01	319	1	1.00	0.03	227								
	Archamia zosterophora (Bleeker, 1858)	1	5.00	0.06	256	1	5.00	0.15	176								
	Cheilodipterus macrodon (Lacepède, 1802)	2	3.50	0.09	240	1	2.00	0.06	217	1	5.00	0.18	166				
	Cheilodipterus quinquelineata (Cuvier, 1828)	3	4.00	0.15	204	2	5.00	0.30	135	1	2.00	0.07	205				
	Sphaeramia nematoptera (Bleeker, 1856)	1	5.00	0.06	257	1	5.00	0.15	176								
	Sphaeramia orbicularis (Kuhl & Van Hasselt, 1828)	1	3.00	0.04	281	1	3.00	0.09	203								
Aulostomidae (Trumpetfishes)							25.00			21				14			
	Aulostomus chinensis (Linnaeus, 1758)	15	2.80	0.52	115	8	2.38	0.58	93	5	3.40	0.61	102	2	3.00	0.30	124
Balistidae (Triggerfishes)																	
	Balistapus undulatus (Park, 1797)	44	4.20	2.28	27	6	3.33	0.61	88	24	4.33	3.71	9	14	4.36	3.05	20
	Balistoides viridescens (Bloch & Schneider, 1801)	19	3.32	0.78	84	1	1.00	0.03	227	13	3.31	1.54	48	5	3.80	0.95	71
	Melichthys niger (Bloch, 1786)	5	3.40	0.21	182					5	3.40	0.61	102				

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
	Melichthys vidua (Solander, 1844)	17	3.88	0.81	82					14	3.86	1.93	36	3	4.00	0.60	91
	Pseudobalistes flavimarginatus (Rüppell, 1829)	3	3.33	0.12	213					1	1.00	0.04	212	2	4.50	0.45	105
	Rhinecanthus aculeatus (Linnaeus, 1758)	18	3.89	0.86	76	9	4.00	1.09	63					9	3.78	1.70	52
	Rhinecanthus rectangulus (Bloch & Schneider, 1801)	10	3.50	0.43	129	2	2.00	0.12	192	8	3.88	1.11	71				
	Rhinecanthus verrucosa (Linnaeus, 1758)	5	3.20	0.20	188	5	3.20	0.48	100								
	Sufflamen bursa (Bloch & Schneider, 1801)	1	5.00	0.06	258					1	5.00	0.18	166				
	Sufflamen chrysopterus (Bloch & Schneider, 1801)	3	3.33	0.12	214	2	4.50	0.27	148	1	1.00	0.04	212				
Belonidae (Needlefishes)																	
	Strongylura incisa (Valenciennes, 1846)	2	3.50	0.09	241					2	3.50	0.25	161				
	Tylosurus crocodilis (Lesueur, 1821)	2	2.50	0.06	259					2	2.50	0.18	166				
Blenniidae (Blennies)																	
	Atrosalarias fuscus (Gunther, 1866)	3	3.33	0.12	215	3	3.33	0.30	135								
	Blenniella chrysospilos (Bleeker, 1857)	10	3.40	0.42	131	3	3.67	0.33	127	6	3.17	0.68	97	1	4.00	0.20	142
	Cirripectes stigmaticus (Strasburg & Schultz, 1953)	1	1.00	0.01	320					1	1.00	0.04	212				
	Cirripectes variolosus (Valenciennes, 1836)	8	3.38	0.33	147	5	3.40	0.52	98	3	3.33	0.36	141				
	Ecsenius opsifrontalis (Chapman & Schultz, 1960)	3	3.33	0.12	216	1	3.00	0.09	203					2	3.50	0.35	119
	Meiacanthus ditrema (Smith - Vaniz, 1976)	2	3.00	0.07	250	2	3.00	0.18	167								
	Meiacanthus grammistes (Valenciennes, 1836)	1	1.00	0.01	321	1	1.00	0.03	227								
	Plagiotremus rhynorhynchus (Bleeker, 1852)	2	1.50	0.04	282	1	1.00	0.03	227					1	2.00	0.10	174
	Plagiotremus tapienosoma (Bleeker, 1857)	6	3.33	0.25	169	5	3.80	0.58	93					1	1.00	0.05	190
	Salarias fasciatus (Bloch, 1786)	1	3.00	0.04	283	1	3.00	0.09	203								
	Salarias segmentatus (Bath & Randall, 1990)	1	4.00	0.05	273	1	4.00	0.12	192								
Caesionidae (Fusiliers)																	
	Caesio caerulaurea (Lacepède, 1801)	11	3.27	0.44	126	3	2.00	0.18	167	8	3.75	1.07	74				
	Caesio lunaris (Cuvier, 1830)	3	4.33	0.16	200					3	4.33	0.46	126				
	Pterocaesio tile (Cuvier, 1830)	5	3.60	0.22	177	2	2.50	0.15	176	3	4.33	0.46	126				
Callionymidae (Dragonets)																	
	Synchiropus ocellatus (Pallus, 1770)	1	1.00	0.01	322	1	1.00	0.03	227								
	Synchiropus spendidus (Herre, 1927)	1	1.00	0.01	323	1	1.00	0.03	227								
Carangidae (Jacks & Trevallys)																	
	Atule mate (Cuvier, 1833)	1	5.00	0.06	260					1	5.00	0.18	166				
	Caranx ignobilis (Forsskål, 1775)	1	1.00	0.01	324					1	1.00	0.04	212				
	Caranx lugubris (Poey, 1860)	22	3.68	1.00	71	3	2.00	0.18	167	13	3.85	1.79	40	6	4.17	1.25	64
	Caranx melampygus (Cuvier, 1833)	1	3.00	0.04	284	1	3.00	0.09	203								
	Scomberoides lysan (Forsskål, 1775)	4	3.25	0.16	201					3	3.33	0.36	141	1	3.00	0.15	156
	Scomberoides lysan (Forsskål, 1775)	1	2.00	0.02	312	1	2.00	0.06	217								
Chaetodontodae (Butterflyfishes)																	
	Chaetodon auriga (Forsskål, 1775)	60	4.12	3.05	10	30	4.33	3.94	8	15	4.00	2.14	30	15	3.80	2.85	23
	Chaetodon baronessa (Cuvier, 1831)	3	2.67	0.10	234	3	2.67	0.24	159								

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
	Chaetodon bennetti (Cuvier, 1831)	18	2.89	0.64	95	2	2.00	0.12	192	11	3.00	1.18	65	5	3.00	0.75	81
	Chaetodon citrinellus (Cuvier, 1831)	49	4.16	2.52	19	11	3.64	1.21	59	23	4.13	3.39	11	15	4.60	3.45	15
	Chaetodon ephippium (Cuvier, 1831)	55	3.45	2.35	25	23	3.39	2.36	30	17	2.71	1.64	45	15	4.40	3.30	17
	Chaetodon kleinii (Bloch, 1790)	18	2.78	0.62	100	8	2.25	0.55	95	7	3.14	0.79	92	3	3.33	0.50	99
	Chaetodon lineolatus (Cuvier, 1831)	12	2.58	0.38	140	7	3.29	0.70	83	1	1.00	0.04	212	4	1.75	0.35	119
	Chaetodon lunula (Lacepède, 1803)	66	4.15	3.38	6	24	4.21	3.06	20	23	3.78	3.11	13	19	4.53	4.30	5
	Chaetodon lunulatus (Quoy & Gaimard, 1824)	38	4.05	1.90	38	16	4.19	2.03	34	15	3.73	2.00	35	7	4.43	1.55	55
	Chaetodon melannotus (Bloch, 1801)	33	3.58	1.46	48	14	3.71	1.58	44	6	2.83	0.61	102	13	3.77	2.45	28
	Chaetodon meyeri (Schneider, 1801)	9	2.89	0.32	152	4	2.50	0.30	135					5	3.20	0.80	80
	Chaetodon ornatissimus (Cuvier, 1831)	14	3.50	0.60	102					11	3.91	1.54	48	3	2.00	0.30	124
	Chaetodon oxycephalus (Bleeker, 1853)	1	2.00	0.02	301									1	2.00	0.10	174
	Chaetodon punctatofasciatus (Cuvier, 1831)	15	3.00	0.56	110					10	3.20	1.14	67	5	2.60	0.65	86
	Chaetodon rafflesii (Bennett, 1830)	24	3.29	0.98	73	5	2.60	0.39	112	13	3.62	1.68	44	6	3.17	0.95	71
	Chaetodon reticulatus (Cuvier, 1831)	37	4.27	1.95	37					24	4.63	3.96	7	13	3.62	2.35	30
	Chaetodon semeion (Bleeker, 1855)	20	3.00	0.74	88	6	3.67	0.67	83	6	3.17	0.68	97	8	2.38	0.95	71
	Chaetodon trifascialis (Quoy & Gaimard, 1824)	50	3.80	2.35	26	23	3.43	2.39	28	9	3.33	1.07	74	18	4.50	4.05	8
	Chaetodon ulietensis (Cuvier , 1831)	32	3.59	1.42	49	13	3.69	1.45	47	6	3.83	0.82	90	13	3.38	2.20	34
	Chaetodon unimaculatus (Bloch, 1787)	17	3.65	0.77	87	3	3.67	0.33	127	4	3.25	0.46	126	10	3.80	1.90	45
	Chaetodon vagabundus (Linnaeus, 1758)	34	3.26	1.37	52	7	3.57	0.76	76	18	3.22	2.07	33	9	3.11	1.40	60
	Forcipiger flavissimus (Jordan & McGregor, 1898)	24	3.83	1.14	65	3	4.33	0.39	112	15	4.00	2.14	30	6	3.17	0.95	71
	Forcipiger longirostris (Broussonet, 1782)	27	3.96	1.32	55	2	5.00	0.30	135	16	3.63	2.07	33	9	4.33	1.95	43
	Hemitaurichthys polylepis (Bleeker, 1857)	10	3.70	0.46	123					10	3.70	1.32	55				
	Heniochus chrysostomus (Cuvier,1831)	48	3.77	2.23	28	16	3.56	1.73	41	24	3.96	3.39	11	8	3.63	1.45	58
	Heniochus monoceros (Cuvier, 1831)	9	3.56	0.40	135	1	1.00	0.03	227	8	3.88	1.11	71				
	Heniochus singularis (Smith & Radcliffe, 1911)	3	4.00	0.15	205					3	4.00	0.43	133				
	Heniochus varius (Cuvier, 1829)	10	3.60	0.44	127					10	3.60	1.29	57				
Cirrhitidae (Hawkfishes)																	
	Paracirrhites arcatus (Cuvier, 1829)	9	2.67	0.30	158	2	3.00	0.18	167	6	2.67	0.57	110	1	2.00	0.10	174
	Paracirrhites forsteri (Schneider, 1801)	6	2.83	0.21	183					6	2.83	0.61	102				
	Paracirrhites hemistichtus (Günther, 1874)	1	2.00	0.02	302									1	2.00	0.10	174
Diodontidae (Porcupinefishes)																	
	Diodon hystrix (Linnaeus, 1758)	2	1.00	0.02	303					1	1.00	0.04	212	1	1.00	0.05	190
Echeneidae (Remoras)																	
	Echeneis naucrates (Linnaeus, 1758)	1	1.00	0.01	326					1	1.00	0.04	212				
Ephipidae (Spadefishes)																	
	Platax teira (Forsskål, 1775)	2	4.50	0.11	222					2	4.50	0.32	148				
Fistularidae (Cornetfishes)																	
	Fistularia commersoni (Rüppell, 1836)	10	2.60	0.32	153	3	3.00	0.27	148	4	2.50	0.36	141	3	2.33	0.35	119
Gerriidae (Mojarras)																	
	Gerres oyena (Forsskål, 1775)	1	1.00	0.01	327					1	1.00	0.04	212				

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
Gobiidae (Gobies)																	
	Amblyeleotris steinitzi (Klausewitz 1974)	5	4.20	0.26	166	5	4.20	0.64	86								
	Amblygobius decussatus (Bleeker, 1855)	1	5.00	0.06	263	1	5.00	0.15	176								
	Amblygobius phalaena (Valenciennes, 1837)	4	3.00	0.15	206	4	3.00	0.36	120								
	Coryphopterus neophytus (Günther, 1877)	1	2.00	0.02	304									1	2.00	0.10	174
	Cryptocentrus cinctus (Herre, 1936)	1	3.00	0.04	286	1	3.00	0.09	203								
	Eviota pellucida (Larson, 1976)	1	5.00	0.06	264	1	5.00	0.15	176								
	Eviota punctulata (Jewett & Lachner, 1983)	1	3.00	0.04	287									1	3.00	0.15	156
	Exyrias bellissimus (Smith, 1959)	1	1.00	0.01	328	1	1.00	0.03	227								
	Gnatholepis anjerensis (Bleeker, 1850)	4	2.50	0.12	217	4	2.50	0.30	135								
	Gnatholepis cauerensis (Bleeker, 1850)	1	1.00	0.01	329	1	1.00	0.03	227								
	Istigobius decoratus (Herre, 1927)	2	3.50	0.09	242	2	3.50	0.21	162								
	Valenciennea sexguttata (Valenciennes, 1837)	1	1.00	0.01	329	1	1.00	0.03	227								
Haemulidae (Sweetlips & Grunts)																	
	Plectorhinchus albovittatus (Rüppell, 1838)	4	2.75	0.14	211	1	2.00	0.06	217	3	3.00	0.32	148				
	Plectorhinchus gibbosus (Lacepède, 1820)	1	2.00	0.02	305	1	2.00	0.06	217								
	Plectorhinchus lessoni (Cuvier, 1830)	10	2.80	0.35	144	5	2.80	0.42	106	4	3.00	0.43	133	1	2.00	0.10	174
	Plectorhinchus lineatus (Valenciennes, 1835)	21	3.00	0.78	85	10	2.50	0.76	76	11	3.45	1.36	52				
	Plectorhinchus picus (Cuvier, 1830)	4	3.50	0.17	195					1	5.00	0.18	166				
	Plectorhinchus vittatus (Linnaeus, 1758)	6	3.33	0.25	170	4	3.75	0.45	102	2	2.50	0.18	166				
Hemiramphidae (Halfbeaks)																	
	Hemiramphus far (Forsskål, 1775)	2	2.50	0.06	265	2	2.50	0.15	176								
	Hemirhamphus lutkei (Valenciennes, 1846)	6	3.50	0.26	167	2	3.00	0.18	167	1	3.00	0.11	194	3	4.00	0.60	91
Holocentridae (Squirrelfishes)																	
	Myripristis adusta (Bleeker, 1853)	6	3.17	0.23	172	1	2.00	0.06	217	4	4.00	0.57	110	1	1.00	0.05	190
	Myripristis berndti (Jordan & Evermann, 1903)	13	3.08	0.49	117	8	2.88	0.70	83	4	3.25	0.46	126	1	4.00	0.20	142
	Myripristis kuntee (Valenciennes, 1831)	38	3.87	1.81	39	14	3.86	1.64	43	15	4.27	2.29	24	9	3.22	1.45	58
	Myripristis murdjan (Forsskål, 1775)	4	2.75	0.14	212	4	2.75	0.33	127								
	Myripristis violacea (Bleeker, 1851)	2	4.50	0.11	223	1	4.00	0.12	192	1	5.00	0.18	166				
	Myripristis woodsi (Greenfield, 1974)	4	3.00	0.15	207	1	3.00	0.09	203	3	3.00	0.32	148				
	Neoniphon argenteus (Valenciennes, 1831)	3	4.00	0.15	208	3	4.00	0.36	120								
	Neoniphon opercularis (Valenciennes, 1831)	3	1.33	0.05	274	3	1.33	0.12	192								
	Neoniphon sammara (Forsskål, 1775)	20	3.50	0.86	77	16	3.25	1.58	44	1	4.00	0.14	185	3	4.67	0.70	85
	Sargocentron caudimaculatum (Rüppell, 1838)	4	2.25	0.11	224	1	5.00	0.15	176	3	1.33	0.14	185				
	Sargocentron microstoma (Günther, 1859)	6	3.33	0.25	171	5	3.40	0.52	98					1	3.00	0.15	156
	Sargocentron spiniferum (Forsskål, 1775)	18	3.50	0.78	86	6	4.17	0.76	76	10	3.40	1.21	64	2	2.00	0.20	142
Kyphosidae (Chubs)																	
	Kyphosus cinerascens (Forsskål, 1775)	11	3.45	0.47	121	4	2.50	0.30	135	5	4.00	0.71	94	2	4.00	0.40	112
	Kyphosus vaigiensis (Quoy & Gaimard, 1825)	16	3.63	0.72	91	3	3.67	0.33	127	12	3.67	1.57	46	1	3.00	0.15	156

Table 3 (continued)

Family	*Species*	Total (81) N	Ave.	Score	Rank	Back-reef (33) N	Ave.	Score	Rank	Fore-reef (28) N	Ave.	Score	Rank	Channel (20) N	Ave.	Score	Rank
Labridae (Wrasses)																	
	Anampses caeruleopunctatus (Rüppell, 1829)	1	1.00	0.01	330					1	1.00	0.04	212				
	Anampses melanurus (Bleeker, 1857)	1	2.00	0.02	306					1	2.00	0.07	205				
	Anampses meleagrides (Valenciennes, 1840)	1	2.00	0.02	307					1	2.00	0.07	205				
	Anampses twistii (Bleeker, 1856)	9	2.78	0.31	156	5	3.00	0.45	102	2	2.50	0.18	166	2	2.50	0.25	133
	Bodianus axillaris (Bennett, 1831)	4	2.00	0.10	230					4	2.00	0.29	155				
	Bodianus mesothorax (Schneider, 1801)	1	4.00	0.05	275					1	4.00	0.14	185				
	Cheilinus fasciatus (Bloch, 1791)	41	3.12	1.58	42	20	2.75	1.67	42	10	3.50	1.25	58	11	3.45	1.90	45
	Cheilinus trilobatus (Lacepède, 1801)	17	3.00	0.63	98	7	3.43	0.73	80	9	2.56	0.82	90	1	4.00	0.20	142
	Cheilinus undulatus (Rüppell, 1835)	46	3.87	2.20	31	25	4.24	3.21	16	9	4.33	1.39	51	12	2.75	1.65	53
	Cheilio inermis (Forsskål, 1775)	7	3.14	0.27	163	4	3.50	0.42	106	3	2.67	0.29	155				
	Choerodon anchorago (Bloch, 1791)	23	3.65	1.04	67	17	3.47	1.79	39					6	4.17	1.25	64
	Coris aygula (Lacepède, 1801)	7	3.00	0.26	168					4	2.75	0.39	139	3	3.33	0.50	99
	Coris gaimard (Quoy & Gaimard, 1824)	10	2.50	0.31	157	4	2.75	0.33	127	5	2.40	0.43	133	1	2.00	0.10	174
	Epibulus insidiator (Pallas, 1770)	56	3.50	2.42	22	23	2.70	1.88	38	15	3.60	1.93	36	18	4.44	4.00	9
	Gomphosus varius (Lacepède, 1801)	54	3.72	2.48	21	22	3.91	2.61	25	22	3.77	2.96	16	10	3.20	1.60	54
	Halichoeres chloropterus (Bloch, 1791)	1	2.00	0.02	308	1	2.00	0.06	217								
	Halichoeres hortulanus (Lacepède, 1801)	49	3.65	2.21	30	14	3.71	1.58	44	21	3.62	2.71	19	14	3.64	2.55	27
	Halichoeres leucurus (Walbaum, 1792)	1	3.00	0.04	288	1	3.00	0.09	203								
	Halichoeres margaritaceus (Valenciennes, 1839)	19	3.58	0.84	79	10	3.40	1.03	66	8	4.00	1.14	67	1	2.00	0.10	174
	Halichoeres marginatus (Rüppell, 1835)	22	3.14	0.85	78	11	3.18	1.06	65	6	2.83	0.61	102	5	3.40	0.85	79
	Halichoeres melanurus (Bleeker, 1851)	12	3.67	0.54	112	3	3.00	0.27	148	7	3.86	0.96	77	2	4.00	0.40	112
	Halichoeres pallidus (Kuiter & Randall, 1995)	3	4.67	0.17	196	3	4.67	0.42	106								
	Halichoeres papilionaceus (Valenciennes, 1839)	3	3.00	0.11	225	3	3.00	0.27	148								
	Halichoeres richmondi (Fowler & Bean, 1928)	1	3.00	0.04	289					1	3.00	0.11	194				
	Halichoeres trimaculatus (Quoy & Gaimard, 1834)	37	4.35	1.99	36	23	4.52	3.15	17					14	4.07	2.85	23
	Hemigymnus fasciatus (Bloch, 1792)	14	2.64	0.46	124	1	5.00	0.15	176	12	2.58	1.11	71	1	1.00	0.05	190
	Hemigymnus melapterus (Bloch, 1791)	56	4.04	2.79	14	25	4.12	3.12	18	17	3.71	2.25	28	14	4.29	3.00	21
	Labrichthys unilineatus (Guichenot, 1847)	10	2.90	0.36	143	7	2.86	0.61	88	2	2.50	0.18	166	1	4.00	0.20	142
	Labroides bicolor (Fowler & Bean, 1928)	25	4.08	1.26	59	15	4.33	1.97	36	6	4.00	0.86	85	4	3.25	0.65	86
	Labroides dimidiatus (Valenciennes, 1839)	63	4.22	3.28	7	26	3.96	3.12	18	19	4.37	2.96	16	18	4.44	4.00	9
	Labropsis micronesica (Randall, 1981)	5	3.80	0.23	173	2	4.50	0.27	148	1	2.00	0.07	205	2	4.00	0.40	112
	Labropsis xanthonota (Randall, 1981)	1	5.00	0.06	266									1	5.00	0.25	133
	Macropharyngodon meleagris (Valenciennes, 1839)	2	3.00	0.07	251									2	3.00	0.30	124
	Novaculichthys taeniourus (Lacepède, 1801)	6	2.33	0.17	197	5	2.60	0.39	112	1	1.00	0.04	212				
	Oxycheilinus unifasciatus (Streets, 1877)	7	3.43	0.30	159	3	4.33	0.39	112	4	2.75	0.39	139				
	Pseudocheilinus hexataenia (Bleeker, 1857)	15	3.20	0.59	105	10	3.60	1.09	63	3	1.67	0.18	166	2	3.50	0.35	119
	Pseudodax moluccanus (Valenciennes, 1839)	2	4.00	0.10	231	1	3.00	0.09	203					1	5.00	0.25	133
	Stethojulis bandanensis (Bleeker, 1851)	31	3.58	1.37	53	15	3.20	1.45	47	8	4.00	1.14	67	8	3.88	1.55	55
	Stethojulis strigiventer (Bennett, 1833)	7	4.14	0.36	141	4	3.50	0.42	106	1	5.00	0.18	166	2	5.00	0.50	99

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**	**N**	**Ave.**	**Score**	**Rank**
	Stethojulis trilineata (Bloch & Schneider, 1801)	1	5.00	0.06	267					1	5.00	0.18	166				
	Thalassoma amblycephalum (Bleeker, 1856)	46	4.22	2.40	24	14	3.29	1.39	49	18	4.78	3.07	14	14	4.43	3.10	19
	Thalassoma hardwicke (Bennett, 1830)	57	4.28	3.01	11	31	4.68	4.39	4	7	2.71	0.68	97	19	4.21	4.00	9
	Thalassoma janseni (Bleeker, 1856)	6	2.17	0.16	202	1	1.00	0.03	227	5	2.40	0.43	133				
	Thalassoma lunare (Linnaeus, 1758)	5	3.60	0.22	178	1	1.00	0.03	227	3	4.67	0.50	119	1	3.00	0.15	156
	Thalassoma lutescens (Lay & Bennett, 1839)	9	2.56	0.28	161	4	2.50	0.30	135	4	2.25	0.32	148	1	4.00	0.20	142
	Thalassoma purpureum (Forsskål, 1775)	8	3.00	0.30	160					8	3.00	0.86	85				
	Thalassoma quinquevittatum (Lay & Bennett, 1839)	17	3.47	0.73	90	1	5.00	0.15	176	16	3.38	1.93	36				
	Xyrichtys pavo (Valenciennes, 1839)	4	3.75	0.19	191	3	4.00	0.36	120	1	3.00	0.11	194				
Letherinidae (Emperors)																	
	Gnathodentex aurolineatus (Lacepède, 1802)	17	3.00	0.63	99	12	3.25	1.18	61	3	2.33	0.25	161	2	2.50	0.25	133
	Lethrinus amboinensis (Bleeker, 1854)	6	2.83	0.21	184	4	2.75	0.33	127					2	3.00	0.30	124
	Lethrinus erythracanthus (Cuvier, 1830)	2	3.00	0.07	252	1	1.00	0.03	227	1	5.00	0.18	166				
	Lethrinus harak (Forsskål, 1775)	33	3.64	1.48	46	16	3.69	1.79	39	7	3.43	0.86	85	10	3.70	1.85	48
	Lethrinus obsoletus (Forsskål, 1775)	4	4.75	0.23	174	3	4.67	0.42	106					1	5.00	0.25	133
	Lethrinus olivaceus (Valenciennes, 1830)	2	4.00	0.10	232	1	3.00	0.09	203	1	5.00	0.18	166				
	Lethrinus xanthochilus (Klunzinger, 1870)	5	2.80	0.17	198					5	2.80	0.50	119				
	Monotaxis grandoculis (Forsskål, 1775)	30	3.97	1.47	47	11	3.91	1.30	51	13	4.15	1.93	36	6	3.67	1.10	67
Lutjanidae (Snappers)																	
	Aphareus furca (Lacepède, 1802)	5	4.40	0.27	164					5	4.40	0.79	92				
	Aprion virescens (Valenciennes, 1830)	1	3.00	0.04	290					1	3.00	0.11	194				
	Lutjanus bohar (Forsskål 1775)	6	3.67	0.27	165	2	4.50	0.27	148	2	4.50	0.32	148	2	2.00	0.20	142
	Lutjanus ehrenbergi (Peters, 1869)	17	3.53	0.74	89	9	3.00	0.82	73	6	4.00	0.86	85	2	4.50	0.45	105
	Lutjanus fulvus (Schneider, 1801)	14	3.43	0.59	106	9	3.44	0.94	68	2	3.50	0.25	161	3	3.33	0.50	99
	Lutjanus gibbus (Forsskål, 1775)	30	3.57	1.32	54	11	3.73	1.24	56	11	3.45	1.36	52	8	3.50	1.40	60
	Lutjanus monostigma (Cuvier, 1828)	11	3.64	0.49	118	7	4.14	0.88	71	3	2.67	0.29	155	1	3.00	0.15	156
	Lutjanus semicinctus (Quoy & Gaimard, 1824)	1	3.00	0.04	291					1	3.00	0.11	194				
	Macolor macularis (Fowler, 1931)	9	3.89	0.43	130					7	3.71	0.93	78	2	4.50	0.45	105
	Macolor niger (Forsskål, 1775)	9	3.56	0.40	136					6	3.33	0.71	94	3	4.00	0.60	91
Microdesmidae (Dartfishes)																	
	Ptereleotris evides (Jordan & Hubbs, 1925)	7	3.71	0.32	154	4	3.75	0.45	102					3	3.67	0.55	96
	Ptereleotris heteroptera (Bleeker, 1855)	2	1.50	0.04	292	2	1.50	0.09	203								
	Ptereleotris microlepis (Bleeker, 1856)	1	1.00	0.01	331	1	1.00	0.03	227								
Monocanthidae (Filefishes)																	
	Aluterus scriptus (Osbeck, 1765)	1	1.00	0.01	332					1	1.00	0.04	212				
	Cantherhines dumerilii (Hollard, 1854)	13	3.77	0.60	104	3	3.67	0.33	127	9	3.89	1.25	58	1	3.00	0.15	156
Monodactylidae (Monos)																	
	Monodactylus argenteus (Linnaeus, 1758)	1	1.00	0.01	333	1	1.00	0.03	227								
Mugilidae (Mullets)																	
	Ellochelon vaigiensis (Quoy & Gaimard, 1825)	1	1.00	0.01	334	1	1.00	0.03	227								

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
Mullidae (Goatfishes)																	
	Mulloidichthys flavolineatus (Lacepède, 1801)	22	3.82	1.04	68	19	3.95	2.27	31	2	2.50	0.18	166	1	4.00	0.20	142
	Mulloidichthys vanicolensis (Valenciennes, 1831)	4	2.25	0.11	226	4	2.25	0.27	148								
	Parupeneus barberinoides (Bleeker, 1852)	17	3.41	0.72	92	5	3.00	0.45	102	10	3.50	1.25	58	2	4.00	0.40	112
	Parupeneus barberinus (Lacepède, 1802)	36	3.56	1.58	43	17	3.76	1.94	37	7	2.86	0.71	94	12	3.67	2.20	34
	Parupeneus cyclostomus (Lacepède, 1801)	18	2.94	0.65	94	5	2.40	0.36	120	6	2.50	0.54	115	7	3.71	1.30	63
	Parupeneus multifasciatus (Quoy & Gaimard, 1825)	50	3.24	2.00	35	22	3.59	2.39	28	16	2.75	1.57	46	12	3.25	1.95	43
Muraenidae (Morays)																	
	Gymnothorax javanicus (Bleeker, 1859)	3	3.00	0.11	227					2	2.00	0.14	185	1	5.00	0.25	133
	Gymnothorax meleagris (Shaw & Nodder, 1795)	1	1.00	0.01	335					1	1.00	0.04	212				
Nemipteridae (Spinecheeks)																	
	Scolopsis bilineata (Bloch, 1793)	3	2.67	0.10	233	2	2.50	0.15	176					1	3.00	0.15	156
	Scolopsis ciliata (Lacepède, 1802)	2	3.50	0.09	243	2	3.50	0.21	162								
	Scolopsis lineata (Quoy & Gaimard, 1824)	26	3.77	1.21	62	23	4.04	2.82	24					3	1.67	0.25	133
	Scolopsis trilineata (Kner, 1868)	21	3.90	1.01	70	10	4.10	1.24	56					11	3.73	2.05	40
Ostraciidae (Boxfishes)																	
	Ostracion meleagris (Shaw 1796)	10	3.80	0.47	122	5	4.00	0.61	88	4	3.75	0.54	115	1	3.00	0.15	156
Pempheridae (Sweepers)																	
	Pempheris otaitensis (Lesson, 1830)	6	2.83	0.21	185					6	2.83	0.61	102				
Pomacanthidae (Angelfishes)																	
	Centropyge bicolor (Bloch, 1787)	8	3.38	0.33	148	2	2.50	0.15	176	4	3.25	0.46	126	2	4.50	0.45	105
	Centropyge loricula (Günther, 1860)	2	4.00	0.10	234					2	4.00	0.29	155				
	Centropyge tibicen (Cuvier, 1831)	1	2.00	0.02	309									1	2.00	0.10	174
	Centropyge vrolikii (Bleeker, 1853)	21	3.19	0.83	81	8	3.00	0.73	80	11	3.36	1.32	55	2	3.00	0.30	124
	Pomacanthus sexstriatus (Cuvier, 1831)	3	1.33	0.05	276	1	1.00	0.03	227					2	1.50	0.15	156
	Pomacanthus xanthometopon (Bleeker, 1853)	13	2.62	0.42	132					4	3.50	0.50	119	9	2.22	1.00	70
	Pygoplites diacanthus (Boddaert, 1772)	37	3.46	1.58	44	8	3.00	0.73	80	18	3.50	2.25	28	11	3.73	2.05	40
Pomacentridae (Damselfishes)																	
	Abudefduf septemfasciatus (Cuvier, 1830)	3	4.67	0.17	199					3	4.67	0.50	119				
	Abudefduf sexfasciatus (Lacepède, 1802)	20	3.75	0.93	75	11	3.64	1.21	59	3	4.33	0.46	126	6	3.67	1.10	67
	Abudefduf vaigiensis (Quoy & Gaimard, 1825)	18	4.50	1.00	72	3	3.67	0.33	127	15	4.67	2.50	22				
	Amblygliphidodon aureus (Cuvier, 1830)	2	4.00	0.10	235									2	4.00	0.40	112
	Amblygliphidodon curacao (Bloch, 1787)	46	4.72	2.68	15	25	4.88	3.70	11	3	4.33	0.46	126	18	4.56	4.10	6
	Amblygliphidodon leucogaster (Bleeker, 1847)	5	4.60	0.28	162	2	5.00	0.30	135					3	4.33	0.65	86
	Amblygliphidodon ternatensis (Bleeker)	1	3.00	0.04	293									1	3.00	0.15	156
	Amphiprion clarkii (Bennett 1830)	1	1.00	0.01	337	1	1.00	0.03	227								
	Amphiprion melanopus (Bleeker, 1852)	4	1.75	0.09	244	1	4.00	0.12	192	3	1.00	0.11	194				
	Amphiprion peridaeraion (Bleeker 1855)	1	3.00	0.04	294									1	3.00	0.15	156
	Chromis atripectoralis (Welander & Schultz, 1951)	8	4.00	0.40	137	4	4.00	0.48	100	3	4.00	0.43	133	1	4.00	0.20	142

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
	Chromis atripes (Fowler & Bean, 1928)	1	3.00	0.04	295									1	3.00	0.15	156
	Chromis lepidolepis Bleeker (Bleeker, 1877)	1	2.00	0.02	310									1	2.00	0.10	174
	Chromis margaritifer (Fowler, 1946)	33	4.15	1.69	41	4	3.25	0.39	112	20	4.30	3.07	14	9	4.22	1.90	45
	Chromis ternatensis (Bleeker, 1856)	13	3.85	0.62	101	2	3.00	0.18	167					11	4.00	2.20	34
	Chromis viridis (Cuvier, 1830)	44	4.75	2.58	17	29	4.72	4.15	5					15	4.80	3.60	14
	Chromis weberi (Fowler & Bean, 1928)	1	3.00	0.04	296									1	3.00	0.15	156
	Chromis xanthura (Bleeker, 1854)	6	4.33	0.32	155					6	4.33	0.93	78				
	Chrysiptera biocellata (Quoy & Gaimard, 1824)	19	3.58	0.84	80	8	3.88	0.94	68	3	3.33	0.36	141	8	3.38	1.35	62
	Chrysiptera brownriggii (Bennett, 1828)	11	3.64	0.49	119	1	3.00	0.09	203	9	3.56	1.14	67	1	5.00	0.25	133
	Chrysiptera cyanea (Quoy & Gaimard, 1825)	48	4.25	2.52	20	23	4.39	3.06	20	7	3.71	0.93	78	18	4.28	3.85	13
	Chrysiptera traceyi (Woods & Schultz)	7	3.86	0.33	149					2	4.50	0.32	148	5	3.60	0.90	77
	Chrysiptera unimaculata (Cuvier, 1830)	1	2.00	0.02	311									1	2.00	0.10	174
	Dascyllus aruanus (Linnaeus, 1758)	41	4.29	2.17	32	28	4.29	3.64	12					13	4.31	2.80	25
	Dascyllus melanurus (Bleeker, 1854)	9	3.67	0.41	133	6	3.00	0.55	95					3	5.00	0.75	81
	Dascyllus reticulatus (Richardson, 1846)	14	3.36	0.58	107	5	2.00	0.30	135	1	1.00	0.04	212	8	4.50	1.80	50
	Dascyllus trimaculatus (Rüppell, 1829)	11	3.27	0.44	128	5	4.00	0.61	88	5	3.00	0.54	115	1	1.00	0.05	190
	Dischistodus chrysopoecilus (Schlegel & Müller, 1839)	3	3.33	0.12	218	3	3.33	0.30	135								
	Dischistodus melanotus (Bleeker, 1858)	50	4.74	2.93	13	31	5.00	4.70	3					19	4.32	4.10	6
	Dischistodus perspicillatus (Cuvier, 1830)	25	4.16	1.28	57	20	4.30	2.61	25					5	3.60	0.90	77
	Hemiglyphidodon plagiometopon (Bleeker, 1852)	10	4.30	0.53	114	8	4.63	1.12	62					2	3.00	0.30	124
	Neoglyphidodon melas (Cuvier, 1830)	3	3.33	0.12	219	2	3.00	0.18	167					1	4.00	0.20	142
	Neoglyphidodon nigroris (Cuvier, 1830)	1	1.00	0.01	338	1	1.00	0.03	227								
	Plectroglyphidodon dickii (Liénard, 1839)	12	3.92	0.58	109	2	4.50	0.27	148	9	3.89	1.25	58	1	3.00	0.15	156
	Plectroglyphidodon lacrymatus (Quoy & Gaimard, 1824)	26	3.81	1.22	60	11	3.82	1.27	54	4	3.50	0.50	119	11	3.91	2.15	38
	Plectroglyphidodon leucozonus (Bleeker, 1859)	7	4.00	0.35	145	6	4.33	0.79	75					1	2.00	0.10	174
	Pomacentrus adelus (Allen, 1991)	3	1.67	0.06	268	2	1.50	0.09	203	1	2.00	0.07	205				
	Pomacentrus bankanensis (Bleeker, 1853)	1	5.00	0.06	269	1	5.00	0.15	176								
	Pomacentrus emarginatus (Cuvier, 1830)	4	4.00	0.20	189					4	4.00	0.57	110				
	Pomacentrus grammorhynchus (Fowler, 1918)	4	4.50	0.22	179					3	4.67	0.50	119	1	4.00	0.20	142
	Pomacentrus moluccensis (Bleeker, 1853)	2	3.00	0.07	253	1	5.00	0.15	176					1	1.00	0.05	190
	Pomacentrus pavo (Bloch, 1787)	14	3.71	0.64	96	12	3.58	1.30	51					2	4.50	0.45	105
	Pomacentrus philippinus (Evermann & Seale, 1907)	10	3.20	0.40	138	7	3.00	0.64	86					3	3.67	0.55	96
	Pomacentrus vaiuli (Jordan & Seale, 1906)	5	2.40	0.15	209	2	1.50	0.09	203					3	3.00	0.45	105
	Stegastes albifasciatus (Schlegel & Müller, 1839)	8	3.38	0.33	150	8	3.38	0.82	73								
	Stegastes fasciolatus (Ogilby, 1889)	4	4.25	0.21	186	3	4.33	0.39	112	1	4.00	0.14	185				
	Stegastes lividus (Bloch & Schneider, 1801)	21	4.48	1.16	63	15	4.80	2.18	33					6	3.67	1.10	67
	Stegastes nigricans (Lacepède, 1802)	38	4.55	2.14	34	27	4.59	3.76	10	1	4.00	0.14	185	10	4.50	2.25	32

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
Pseudochromidae (Dottybacks)																	
	Pseudochromis fuscus (Müller & Troschel, 1849)	2	2.50	0.06	270	2	2.50	0.15	176								
	Pseudochromis paccagnellae (Axelrod, 1973)	1	1.00	0.01	339					1	1.00	0.04	212				
Scaridae (Parrotfishes)																	
	Bolbometopon muricatum (Valenciennes, 1839)	6	3.17	0.23	175	2	2.50	0.15	176	3	4.00	0.43	133	1	2.00	0.10	174
	Cetoscarus bicolor (Rüppell, 1829)	29	3.55	1.27	58	7	2.86	0.61	88	16	4.00	2.29	24	6	3.17	0.95	71
	Chlorurus bleekeri (deBeaufort, 1940)	28	3.54	1.22	61	13	3.38	1.33	50	3	3.33	0.36	141	12	3.75	2.25	32
	Chlorurus frontalis (Valenciennes, 1840)	7	3.86	0.33	151	1	4.00	0.12	192	4	4.00	0.57	110	2	3.50	0.35	119
	Chlorurus microrhinos (Bleeker, 1854)	21	3.10	0.80	83	1	2.00	0.06	217	14	3.43	1.71	43	6	2.50	0.75	81
	Chlorurus sordidus (Forsskål, 1775)	79	4.92	4.80	2	33	5.00	5.00	1	28	4.86	4.86	2	18	4.89	4.40	4
	Hipposcarus longiceps (Valenciennes, 1840)	50	3.92	2.42	23	25	3.80	2.88	23	14	4.57	2.29	24	11	3.36	1.85	48
	Scarus altipinnis (Steindachner, 1879)	4	3.75	0.19	192					4	3.75	0.54	115				
	Scarus dimidiatus (Bleeker, 1859)	72	4.65	4.14	4	27	4.70	3.85	9	25	4.40	3.93	8	20	4.90	4.90	1
	Scarus flavipectoralis (Schultz, 1958)	1	1.00	0.01	340	1	1.00	0.01	340								
	Scarus frenatus (Lacepède, 1802)	26	3.50	1.12	66	9	3.11	0.85	72	14	3.57	1.79	40	3	4.33	0.65	86
	Scarus ghobban (Forsskål, 1775)	10	3.70	0.46	125	3	2.67	0.24	159	6	4.17	0.89	82	1	4.00	0.20	142
	Scarus globiceps (Valenciennes, 1840)	12	3.50	0.52	116	3	3.33	0.30	135	7	3.71	0.93	78	2	3.00	0.30	124
	Scarus niger (Forsskål, 1775)	34	3.68	1.54	45	9	4.56	1.24	56	12	3.33	1.43	50	13	3.38	2.20	34
	Scarus oviceps (Valenciennes, 1840)	70	4.74	4.10	5	28	4.89	4.15	5	27	4.78	4.61	3	15	4.40	3.30	17
	Scarus psittacus (Forsskål, 1775)	15	3.87	0.72	93	4	4.50	0.55	95	8	3.75	1.07	74	3	3.33	0.50	99
	Scarus rivulatus (Valenciennes, 1840)	3	2.67	0.10	236					3	2.67	0.29	155				
	Scarus rubriviolaceous (Bleeker, 1849)	12	3.67	0.54	113	2	4.50	0.27	148	10	3.50	1.25	58				
	Scarus schlegeli (Bleeker, 1861)	28	4.04	1.40	50	3	3.00	0.27	148	15	4.27	2.29	24	10	4.00	2.00	42
	Scarus spinus (Kner, 1868)	28	3.75	1.30	56	4	3.25	0.39	112	20	3.95	2.82	18	4	3.25	0.65	86
Scomberidae (Tunas & Mackerels)																	
	Gymnosarda unicolor (Rüppell, 1836)	2	4.00	0.10	237					2	4.00	0.29	155				
Scorpaenidae (Lionfishes)																	
	Pterois antennata (Bloch, 1787)	3	2.33	0.09	245					1	3.00	0.11	194	2	2.00	0.20	142
	Pterois volitans (Linnaeus, 1758)	3	2.33	0.09	246					2	1.50	0.11	194	1	4.00	0.20	142
Serranidae (Basses)																	
	Aethaloperca rogaa (Forsskål, 1775)	1	1.00	0.01	340					1	1.00	0.04	212				
	Cephalopholis argus (Schneider, 1801)	33	3.42	1.40	51	3	2.33	0.21	162	21	3.38	2.54	21	9	3.89	1.75	51
	Cephalopholis miniata (Forsskål, 1775)	2	3.50	0.09	247					2	3.50	0.25	161				
	Cephalopholis urodeta (Forster, 1801)	22	3.45	0.94	74					22	3.45	2.71	19				
	Epinephelus hexagonatus (Forster, 1801)	1	3.00	0.04	297					1	3.00	0.11	194				
	Epinephelus maculatus (Bloch, 1790)	1	2.00	0.02	313									1	2.00	0.10	174
	Epinephelus melanostigmus (Schultz, 1953)	2	3.50	0.09	248	1	4.00	0.12	192					1	3.00	0.15	156
	Epinephelus merra (Bloch, 1793)	16	3.06	0.60	103	11	2.82	0.94	68	1	3.00	0.11	194	4	3.75	0.75	81
	Gracila albomarginata (Fowler & Bean, 1930)	1	3.00	0.04	298									1	3.00	0.15	156
	Pseudanthias bartlettorum (Randall & Lubbock, 1981)	2	5.00	0.12	220					2	5.00	0.36	141				

Table 3 (continued)

Family	*Species*	Total (81)				Back-reef (33)				Fore-reef (28)				Channel (20)			
		N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank	N	Ave.	Score	Rank
	Pseudanthias bicolor (Randall, 1979)	1	4.00	0.05	277					1	4.00	0.14	185				
	Pseudanthias dispar (Herre, 1955)	2	5.00	0.12	221					2	5.00	0.36	141				
	Pseudanthias pascalus (Jordan & Tanaka, 1927)	4	4.25	0.21	187					4	4.25	0.61	102				
	Variola louti (Forsskål, 1775)	2	2.50	0.06	271					2	2.50	0.18	166				
Siganidae (Rabbitfishes)																	
	Siganus vulpinus (Schlegel and Müller, 1845)	13	3.62	0.58	108	1	4.00	0.12	192	7	3.43	0.86	85	5	3.80	0.95	71
	Siganus argenteus (Quoy & Gaimard, 1825)	4	3.75	0.19	193					2	4.50	0.32	148	2	3.00	0.30	124
	Siganus doliatus (Cuvier, 1830)	39	3.64	1.75	40	20	3.70	2.24	32	8	3.13	0.89	82	11	3.91	2.15	38
	Siganus fuscescens (Houttuyn, 1782)	1	2.00	0.02	314	1	2.00	0.06	217								
	Siganus guttatus (Bloch, 1887)	2	3.00	0.07	254	2	3.00	0.18	167								
	Siganus lineatus (Valenciennes, 1835)	6	3.00	0.22	180	4	2.50	0.30	135					2	4.00	0.40	112
	Siganus puellus (Schlegel, 1852)	26	3.23	1.04	69	11	3.00	1.00	67	3	1.67	0.18	166	12	3.83	2.30	31
	Siganus punctatus (Schneider, 1801)	1	1.00	0.01	341	1	1.00	0.03	227								
	Siganus spinus (Linnaeus, 1758)	2	1.50	0.04	299	1	2.00	0.06	217					1	1.00	0.05	190
Sygnathidae (Pipefishes)																	
	Corythoichthys flavofasciatus (Rüppell, 1838)	3	2.67	0.10	238	2	3.50	0.21	162	1	1.00	0.04	212				
	Corythoichthys intestinalis (Ramsay, 1881)	16	3.25	0.64	97	13	3.31	1.30	51					3	3.00	0.45	105
Synodontidae (Lizardfishes)																	
	Saurida gracilis (Quoy & Gaimard, 1824)	1	1.00	0.01	342					1	1.00	0.04	212				
	Synodus binotatus (Schultz, 1953)	1	2.00	0.02	315									1	2.00	0.10	174
	Synodus dermatogenys (Fowler, 1912)	1	5.00	0.06	272	1	5.00	0.15	176								
Syphaerinidae (Barracudas)																	
	Sphyraena barracuda (Walbaum, 1792)	2	2.00	0.05	278					2	2.00	0.14	185				
	Sphyraena flavicauda (Rüppell, 1838)	2	2.00	0.05	279	1	3.00	0.09	203	1	1.00	0.04	212				
	Sphyraena qenie (Klunzinger, 1870)	1	2.00	0.02	316					1	2.00	0.07	205				
Tetradontidae (Pufferfishes)																	
	Arothron manilensis (Procé, 1822)	1	4.00	0.05	280	1	4.00	0.12	192								
	Arothron meleagris (Lacepède, 1798)	1	2.00	0.02	317									1	2.00	0.10	174
	Arothron nigropunctatus (Bloch & Schneider, 1801)	6	2.67	0.20	190	2	2.00	0.12	192					4	3.00	0.60	91
	Canthigaster bennetti (Bleeker, 1854)	2	1.00	0.02	318	2	1.00	0.06	217								
	Canthigaster valentini (Bleeker, 1853)	6	3.17	0.23	176	3	4.00	0.36	120	1	4.00	0.14	185	2	1.50	0.15	156
Toxotidae (Archerfishes)																	
	Toxotes jaculator (Pallas, 1767)	1	1.00	0.01	343	1	1.00	0.03	227								
Zanclidae (Moorish Idols)																	
	Zanclus cornutus (Linnaeus, 1758)	76	4.54	4.26	3	30	4.37	3.97	7	26	4.54	4.21	5	20	4.80	4.80	2
Carcharhinidae (Requiem sharks)																	
	Carcharhinus amblyrhynchos (Bleeker, 1856)	1	5.00	0.06	261					1	5.00	0.18	166				
	Carcharhinus melanopterus (Quoy & Gaimard, 1824)	11	2.64	0.36	142	1	1.00	0.03	227	7	2.57	0.64	100	3	3.33	0.50	99
	Triaenodon obesus (Rüppell, 1837)	2	2.50	0.06	262					2	2.50	0.18	166				

Table 3 (continued)

Family	*Species*	Total (81) N	Ave.	Score	Rank	Back-reef (33) N	Ave.	Score	Rank	Fore-reef (28) N	Ave.	Score	Rank	Channel (20) N	Ave.	Score	Rank
Ginglymostomatidae (Nurse Sharks)																	
	Nebrius ferrugineus (Lesson, 1830)	2	1.50	0.04	285					2	1.50	0.11	194				
Dasyatidae (Stingrays)																	
	Dasyatis kuhli (Müller & Henle, 1841)	1	1.00	0.01	325	1	1.00	0.03	227								
	Pastinachus sephen (Forsskål, 1906)	2	4.00	0.10	229	2	4.00	0.24	159								
Myliobatidae (Eagle Rays)																	
	Aetobatis narinari (Euphrasen, 1790)	1	1.00	0.01	336					1	1.00	0.04	212				

A total of 123 species were encountered across all habitats. Species richness was highest in back-reef habitats (248 total species,) followed by fore-reef (231 species) and channel (196 spp.) habitats, respectively. Estimates of fish densities from transect surveys (Appendix I) and stationary counts (Appendix II) ranged up to roughly 50 individuals/100 m^2 for a variety of species, particularly herbivorous fishes. Electronic versions of all data tables available upon request from KEC.

Discussion

Previous data on Yap's reef fish populations come primarily from the qualitative surveys of Amesbury *et al.* (1978) and Myers (1999) that provide information on occurrence but not abundance. The data provided here provides a baseline of information on fish abundances in Yap that should be useful for assessing the current state of fish populations as well as for monitoring potential changes in reef populations in the future. While the current study adds 114 species to the list for Yap, it should be noted that many of these were expected in the region, given their larger-scale biogeographic distribution.

Our efforts were constrained to easily accessible shallow water habitats that could be surveyed without the use of SCUBA. The results reported here should be judged accordingly. Many small, cryptic species, especially gobies are under represented by visual census techniques and would be better assayed with the use of anesthetics or poisons. Similarly, many nocturnal species that hide within the reef during daylight may have been missed by our techniques. Finally, our surveys were not intended for species that tend to occur at depths below 10 m. These caveats help explain the 164 species listed as occurring in Yap (Myers 1999) but that we did not encounter.

The rich and abundant assemblages of reef fish encountered during our surveys indicate that Yap currently maintains a healthy and vital complex of reef-associated communities across a variety of habitat types. Coral associated species (e.g. butterflyfishes), often used as an indicator of overall coral reef health (e.g., Crosby & Reese 1996) were notably diverse and numerous. Of the 27 species of butterflyfishes encountered, ten ranked within the fifty most common fishes across all sites. We also encountered abundant populations of many herbivorous fishes that, in turn, presumably help support the many species of predatory fishes we encountered.

In sum, we hope this quantitative assessment of Yap's marine resources will encourage further study in the area. Future surveys, following similar methods, will begin to provide a sense of how reef fish populations within the region are changing in both space and time. Data on occurrence and abundance of species over time may also be of use to those interested in the origins and maintenance of biogeographic distributions (e.g. Myers 1999).

Acknowledgements.

We are grateful to the people of Yap for permission to conduct this research on their reefs. A. Tafileichig and the staff of the Yap Marine Resources and Management Division provided outstanding logistical support during field operations. S. Amesbury, V. Paul, R. Richmond, and. R Tsuda of the University of Guam Marine Laboratory contributed many valuable insights and contacts both prior to, and during, the study. R. Myers graciously provided an electronic version of his fish list for comparison with our results. L. Clifton, L. Cookler, S. Dennett, S. Hayes, K. Hunt-Morr S. Jetter, S. Raphael, M. Ronick, and M. Tilghman helped with data collection. The Department of Biology at Lewis and Clark College supported data analysis and manuscript preparation.

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Appendix I (Part A). Mean densities (# •100m^{-2}) of the 80 most commonly seen fish species during transect surveys across all sites (total) and by site (West and North sites given first, East and South sites in part B, below. Number of surveys given in parentheses). "% obs" = the percent of surveys in which the species was encountered. "Enc. density" = mean density of a species when encountered (excludes transects when a species was not encountered). Overall density provides a mean for all transects (density of zero for transects with no encounter).

	All reefs			West Reefs						North Reefs		
	Total (201)			Yyin (66)			Mi'l (28)			North (16)		
Species	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**
Chlorurus sordidus	0.92	26.74	24.47 ± 1.667	0.31	20.67	20.04 ± 2.659	0.86	16.33	14.00 ± 2.661	1.00	46.13	46.12 ± 7.781
Ctenochaetus striatus	0.95	19.86	18.87 ± 1.126	0.19	12.22	11.84 ± 1.302	0.96	14.81	14.28 ± 1.354	1.00	21.19	21.18 ± 3.905
Scarus dimidiatus	0.57	4.17	2.388 ± 0.219	0.07	4.44	2.424 ± 0.425	0.75	3.05	2.285 ± 0.377	0.50	3.13	1.562 ± 0.418
Acanthurus lineatus	0.18	12.44	2.228 ± 0.442				0.71	1.50	0.107 ± 0.078			
Acanthurus triostegus	0.39	5.54	2.149 ± 0.366	0.08	5.12	2.015 ± 0.559	0.39	2.64	1.035 ± 0.335	0.50	7.38	3.687 ± 1.257
Scarus oviceps	0.55	3.60	1.99 ± 0.208	0.06	3.76	2.106 ± 0.394	0.21	2.00	0.428 ± 0.188	0.88	4.64	4.062 ± 1.152
Acanthurus nigricauda	0.36	3.63	1.318 ± 0.204	0.03	1.95	0.651 ± 0.137	0.75	7.48	5.607 ± 1.053	0.25	2.00	0.5 ± 0.258
Acanthurus nigricans	0.30	3.44	1.044 ± 0.168	0.04	2.52	0.803 ± 0.201	0.25	1.71	0.428 ± 0.157	0.38	3.33	1.25 ± 0.495
Ctenochaetus strigosus	0.24	4.23	1.009 ± 0.18	0.06	3.88	0.469 ± 0.284	0.21	3.17	0.678 ± 0.286	0.75	3.25	2.437 ± 0.664
Chaetodon trifascialis	0.36	2.33	0.835 ± 0.108	0.02	1.37	0.621 ± 0.105	0.67	1.82	1.107 ± 0.22	0.25	2.25	0.562 ± 0.288
Chaetodon auriga	0.46	1.71	0.781 ± 0.077	0.03	1.67	0.833 ± 0.135	0.54	1.60	0.857 ± 0.197	0.44	1.71	0.75 ± 0.266
Chaetodon lunulatus	0.30	2.46	0.746 ± 0.101	0.03	1.73	0.393 ± 0.1	0.46	2.08	0.964 ± 0.238	0.69	2.18	1.5 ± 0.365
Parupeneus multifasciatus	0.29	2.28	0.656 ± 0.102	0.04	2.33	0.424 ± 0.182	0.54	2.80	1.500 ± 0.346	0.63	1.30	0.812 ± 0.208
Chaetodon citrinellus	0.26	2.42	0.626 ± 0.095	0.07	4.50	0.136 ± 0.101	0.54	2.20	1.178 ± 0.291	0.56	1.33	0.75 ± 0.193
Neoniphon sammara	0.16	3.56	0.567 ± 0.129	0.05	3.31	0.651 ± 0.258				0.25	4.75	1.187 ± 0.593
Naso lituratus	0.27	1.84	0.502 ± 0.076	0.02	1.00	0.121 ± 0.04	0.21	1.00	0.214 ± 0.078	0.25	2.25	0.562 ± 0.376
Chaetodon melannotus	0.14	2.89	0.402 ± 0.087	0.03	1.67	0.151 ± 0.061	0.64	3.56	2.285 ± 0.465			
Zebrasoma veliferum	0.10	3.81	0.398 ± 0.163	0.03	2.00	0.09 ± 0.056	0.39	6.00	2.357 ± 1.103	0.13	1.00	0.125 ± 0.085
Neoniphon opercularis	0.04	7.56	0.338 ± 0.164	0.05	3.00	0.045 ± 0.045				0.25	14.00	3.5 ± 1.912
Scarus juv.	0.08	4.19	0.333 ± 0.128	0.05	3.30	0.5 ± 0.203	0.36	9.00	0.321 ± 0.321	0.63	2.00	1.25 ± 1.25
Cheilinus undulatus	0.18	1.75	0.313 ± 0.058	0.02	1.46	0.287 ± 0.082	0.14	2.25	0.321 ± 0.163	0.50	1.75	0.875 ± 0.327
Chaetodon ephippium	0.20	1.55	0.308 ± 0.051	0.02	1.33	0.242 ± 0.071	0.29	1.63	0.464 ± 0.158	0.19	2.00	0.375 ± 0.221
Siganus doliatus	0.09	3.39	0.303 ± 0.088									
Lethrinus harak	0.09	3.11	0.293 ± 0.154	0.02	1.17	0.106 ± 0.043	0.14	3.25	0.464 ± 0.259			
Melichthys vidua	0.11	2.59	0.283 ± 0.077				0.36	3.00	0.107 ± 0.107			
Scarus niger	0.10	2.55	0.253 ± 0.071	0.02	1.50	0.09 ± 0.046	0.36	1.00	0.035 ± 0.035	0.19	2.33	0.437 ± 0.257
Acanthurus xanthopterus	0.07	3.33	0.248 ± 0.074	0.03	2.00	0.121 ± 0.063	0.14	5.00	0.714 ± 0.352	0.63	3.00	0.187 ± 0.187
Chaetodon lunula	0.09	2.58	0.243 ± 0.074	0.02	1.00	0.015 ± 0.015				0.31	1.00	0.312 ± 0.119
Chaetodon reticulatus	0.12	1.71	0.203 ± 0.044				0.18	2.00	0.357 ± 0.179			

Appendix I (Part A, continued)

	All reefs			West Reefs						North Reefs		
	Total (201)			Yyin (66)			Mi'l (28)			North (16)		
Species	% obs	Encounter density	Overall density	% obs	Encounter density	Overall density	% obs	Encounter density	Overall density	% obs	Encounter density	Overall density
Scarus spinus	0.08	2.31	0.184 ± 0.073	0.13	8.50	0.257 ± 0.205	0.36	1.00	0.035 ± 0.035			
Neoniphon argenteus	0.05	3.60	0.179 ± 0.066	0.02	1.60	0.121 ± 0.055				0.25	6.25	1.562 ± 0.718
Hipposcarus longiceps	0.06	2.46	0.159 ± 0.064	0.02	1.50	0.09 ± 0.051	0.14	4.00	0.571 ± 0.403	0.25	2.25	0.562 ± 0.288
Parupeneus barberinoides	0.08	1.76	0.149 ± 0.045	0.03	1.86	0.196 ± 0.099	0.21	1.67	0.357 ± 0.164			
Chaetodon kleinii	0.09	1.53	0.144 ± 0.038	0.02	1.00	0.045 ± 0.025	0.18	2.60	0.464 ± 0.227			
Rhinecanthus aculeatus	0.08	1.65	0.139 ± 0.039	0.03	1.67	0.151 ± 0.072	0.17	2.00	0.214 ± 0.148			
Chaetodon vagabundus	0.10	1.35	0.134 ± 0.031	0.02	1.14	0.121 ± 0.045	0.17	2.00	0.214 ± 0.129	0.13	1.50	0.187 ± 0.135
Myripristis kuntee	0.04	3.13	0.124 ± 0.055	0.03	2.00	0.151 ± 0.075						
Gnathodentex aurolineatus	0.00	24.00	0.119 ± 0.119							0.63	24.00	1.5 ± 1.5
Chaetodon unimaculatus	0.06	1.85	0.119 ± 0.041	0.02	1.00	0.015 ± 0.015	0.25	1.71	0.428 ± 0.173	0.13	1.50	0.187 ± 0.135
Balistapus undulatus	0.07	1.64	0.114 ± 0.036				0.18	2.00	0.357 ± 0.193			
Rhinecanthus rectangulus	0.06	1.83	0.109 ± 0.035	0.05	3.00	0.045 ± 0.045	0.14	2.25	0.321 ± 0.178			
Chaetodon ulietensis	0.05	1.90	0.094 ± 0.03	0.03	2.00	0.09 ± 0.051	0.71	1.50	0.107 ± 0.078	0.63	3.00	0.187 ± 0.187
Epibulus insidiator	0.08	1.19	0.094 ± 0.024	0.02	1.00	0.06 ± 0.029	0.17	1.33	0.142 ± 0.084			
Cetoscarus bicolor	0.04	2.00	0.089 ± 0.033				0.21	2.33	0.5 ± 0.208	0.63	2.00	0.125 ± 0.125
Caranx melampygus	0.02	4.25	0.084 ± 0.054				0.71	6.50	0.464 ± 0.369			
Mulloidichthys flavolineatus	0.04	2.13	0.084 ± 0.035	0.04	2.60	0.196 ± 0.101				0.63	2.00	0.125 ± 0.125
Myripristis violacea	0.03	2.33	0.069 ± 0.031									
Forcipiger flavissimus	0.04	1.44	0.064 ± 0.022				0.36	1.00	0.035 ± 0.035	0.63	2.00	0.125 ± 0.125
Chaetodon lineolatus	0.03	2.00	0.059 ± 0.036	0.05	3.00	0.136 ± 0.107	0.36	1.00	0.035 ± 0.035	0.13	1.00	0.125 ± 0.085
Sargocentron spiniferum	0.03	2.00	0.059 ± 0.032							0.13	1.50	0.187 ± 0.135
Chaetodon rafflesii	0.04	1.50	0.059 ± 0.021	0.02	1.00	0.03 ± 0.021						
Lutjanus ehrenbergi	0.04	1.33	0.059 ± 0.021	0.03	1.75	0.106 ± 0.057	0.36	1.00	0.035 ± 0.035	0.63	1.00	0.062 ± 0.062
Cheilinus trilobatus	0.04	1.22	0.059 ± 0.019				0.17	1.67	0.178 ± 0.103			
Siganus puellus	0.03	1.57	0.054 ± 0.024	0.02	1.33	0.06 ± 0.036						
Parupeneus barberinus	0.04	1.22	0.054 ± 0.018	0.02	1.17	0.106 ± 0.043	0.17	1.33	0.142 ± 0.084			
Parupeneus cyclostomus	0.02	2.50	0.049 ± 0.027				0.17	2.00	0.214 ± 0.129			
Rhinecanthus verrucosa	0.03	1.43	0.049 ± 0.019									
Epinephelus merra	0.04	1.25	0.049 ± 0.018	0.02	1.00	0.015 ± 0.015	0.71	1.50	0.107 ± 0.078	0.13	1.00	0.125 ± 0.085
Heniochus chrysostomus	0.04	1.11	0.049 ± 0.016	0.02	1.33	0.06 ± 0.036				0.63	1.00	0.062 ± 0.062
Scarus frenatus	0.04	1.11	0.049 ± 0.016	0.02	1.00	0.015 ± 0.015				0.63	1.00	0.062 ± 0.062
Lutjanus bohar	0.03	1.50	0.044 ± 0.02	0.02	1.60	0.121 ± 0.059				0.63	1.00	0.062 ± 0.062
Plectorhinchus lineatus	0.03	1.33	0.039 ± 0.018	0.02	1.50	0.09 ± 0.051				0.63	1.00	0.062 ± 0.062

Appendix I (Part A, continued)

	All reefs			West Reefs						North Reefs		
	Total (201)			Yyin (66)			Mi'l (28)			North (16)		
Species	**% obs**	**Encounter density**	**Overall density**	**% obs**	**Encounter density**	**Overall density**	**% obs**	**Encounter density**	**Overall density**	**% obs**	**Encounter density**	**Overall density**
Cephalopholis urodeta	0.03	1.14	0.039 ± 0.015				0.71	1.50	0.107 ± 0.078			
Scarus psittacus	0.01	2.33	0.034 ± 0.021	0.03	2.00	0.06 ± 0.047						
Scarus globiceps	0.02	1.40	0.034 ± 0.016	0.02	1.00	0.03 ± 0.021						
Cephalopholis argus	0.03	1.00	0.029 ± 0.012				0.71	1.00	0.071 ± 0.049			
Myripristis woodsi	0.00	5.00	0.024 ± 0.024	0.08	5.00	0.075 ± 0.075						
Sargocentron microstoma	0.01	2.50	0.024 ± 0.02	0.06	4.00	0.06 ± 0.06						
Chlorurus microrhinos	0.01	2.50	0.024 ± 0.02	0.06	4.00	0.06 ± 0.06						
Myripristis berndti	0.01	2.50	0.024 ± 0.017									
Melichthys niger	0.02	1.25	0.024 ± 0.013				0.71	1.50	0.107 ± 0.078			
Lutjanus monostigma	0.02	1.25	0.024 ± 0.013	0.02	1.33	0.06 ± 0.036						
Epinephelus melanostigmus	0.02	1.25	0.024 ± 0.013	0.02	1.00	0.015 ± 0.015						
Chlorurus bleekeri	0.02	1.00	0.024 ± 0.011	0.02	1.00	0.015 ± 0.015	0.36	1.00	0.035 ± 0.035			
Lutjanus gibbus	0.01	2.00	0.019 ± 0.015				0.36	1.00	0.035 ± 0.035	0.63	3.00	0.187 ± 0.187
Lutjanus semicinctus	0.01	2.00	0.019 ± 0.015	0.03	2.00	0.06 ± 0.047						
Chaetodon baronessa	0.01	1.33	0.019 ± 0.012									
Plectorhinchus vittatus	0.01	1.33	0.019 ± 0.012	0.02	1.33	0.06 ± 0.036						
Chlorurus frontalis	0.01	1.33	0.019 ± 0.012									
Lethrinus erythracanthus	0.01	1.00	0.014 ± 0.008	0.02	1.00	0.015 ± 0.015						

Appendix I (Part B). Mean densities (# •100m^{-2}) of the 80 most commonly seen fish species during transect surveys across all sites (total) and by site (West and North sites given above, East and South sites. Number of surveys given in parentheses). "% obs" = the percent of surveys in which the species was encountered. "Enc. density" = mean density of a species when encountered (excludes transects when a species was not encountered). Overall density provides a mean for all transects (density of zero for transects with no encounter).

	East Reefs												South Reefs		
	Goofnuw (23)			Tomil (30)			Barge (12)			Peelaek (16)			South (10)		
Species	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc density**	**Overall density**
Chlorurus sordidus	1.00	3.69	30.6 ± 2.606	0.97	46.52	44.96 ± 4.985	0.92	2.64	18.91 ± 2.734	0.94	12.13	11.37 ± 2.325	0.20	2.50	0.5 ± 0.341
Ctenochaetus striatus	1.00	39.13	39.13 ± 2.941	0.80	7.88	6.3 ± 1.298	1.00	37.67	37.66 ± 4.936	0.94	29.87	28 ± 3.894	1.00	28.40	28.4 ± 3.992
Scarus dimidiatus	0.70	3.38	2.347 ± 0.456	0.67	5.80	3.866 ± 0.75	0.83	5.10	4.25 ± 1.059	0.19	2.67	0.5 ± 0.376	0.10	2.00	0.2 ± 0.2
Acanthurus lineatus	0.87	1.50	0.13 ± 0.095	0.33	2.00	0.066 ± 0.066	0.67	3.75	2.5 ± 0.69	0.81	14.38	11.68 ± 2.332	1.00	22.30	22.3 ± 1.706
Acanthurus triostegus	0.17	12.00	2.086 ± 1.951	0.60	3.56	1.833 ± 0.377	0.25	7.00	1.75 ± 1.073	0.50	10.88	5.437 ± 2.117			
Scarus oviceps	0.87	5.30	4.608 ± 0.67	0.37	1.73	0.633 ± 0.222	0.75	3.22	2.416 ± 0.621	0.69	2.27	1.562 ± 0.353	0.30	1.67	0.5 ± 0.307
Acanthurus nigricauda	0.13	1.00	0.13 ± 0.071	0.53	2.50	1.333 ± 0.3	0.17	4.00	0.666 ± 0.512	0.19	1.00	0.187 ± 0.1	0.20	1.50	0.3 ± 0.213
Acanthurus nigricans	0.17	1.75	0.304 ± 0.159	0.23	1.86	0.433 ± 0.17	0.75	8.78	6.583 ± 1.616	0.13	3.50	0.437 ± 0.376	0.50	3.80	1.9 ± 0.737
Ctenochaetus strigosus	0.69	6.21	3.782 ± 0.893	0.67	2.00	0.133 ± 0.092	0.83	1.00	0.083 ± 0.083	0.13	3.00	0.375 ± 0.314	0.30	5.33	1.6 ± 0.945
Chaetodon trifascialis	0.91	4.14	3.782 ± 0.47												
Chaetodon auriga	0.65	2.13	1.391 ± 0.325	0.43	1.69	0.733 ± 0.197	0.17	1.50	0.25 ± 0.179	0.25	1.50	0.375 ± 0.179	0.30	1.00	0.3 ± 0.152
Chaetodon lunulatus	0.69	4.71	2.478 ± 0.547	0.67	3.00	0.2 ± 0.168	0.83	1.00	0.083 ± 0.083				0.50	1.80	0.9 ± 0.314
Parupeneus multifasciatus	0.43	1.00	0.043 ± 0.043	0.53	2.63	1.4 ± 0.351	0.83	1.00	0.083 ± 0.083	0.13	2.00	0.25 ± 0.193	0.10	1.00	0.1 ± 0.1
Chaetodon citrinellus	0.74	2.82	2.086 ± 0.444				0.83	3.00	0.25 ± 0.25	0.31	2.00	0.625 ± 0.286	0.30	3.67	1.1 ± 0.566
Neoniphon sammara	0.27	1.83	0.478 ± 0.234	0.30	4.56	1.366 ± 0.508									
Naso lituratus	0.52	1.50	0.782 ± 0.217	0.33	3.00	1 ± 0.295	0.42	2.20	0.916 ± 0.451	0.44	2.29	1 ± 0.365	0.30	1.00	0.3 ± 0.152
Chaetodon melannotus	0.17	1.75	0.304 ± 0.159												
Zebrasoma veliferum	0.87	1.00	0.086 ± 0.06	0.10	1.33	0.133 ± 0.079									
Neoniphon opercularis				0.10	2.67	0.266 ± 0.165							0.10	1.00	0.1 ± 0.1
Scarus juv.	0.43	1.00	0.043 ± 0.043	0.10	1.33	0.133 ± 0.079									
Cheilinus undulatus	0.87	1.00	0.086 ± 0.06	0.30	2.11	0.633 ± 0.232									
Chaetodon ephippium	0.34	1.43	0.434 ± 0.151	0.20	1.33	0.266 ± 0.106				0.25	2.25	0.562 ± 0.328			
Siganus doliatus	0.27	1.33	0.347 ± 0.134	0.37	4.64	1.7 ± 0.512							0.10	2.00	0.2 ± 0.2
Lethrinus harak	0.13	1.00	0.13 ± 0.071	0.67	1.00	0.066 ± 0.046	0.17	1.00	0.166 ± 0.112	0.63	2.00	0.125 ± 0.125	0.10	30.00	3 ± 3
Melichthys vidua							0.67	3.00	2 ± 0.879	0.63	2.60	1.625 ± 0.446	0.30	1.33	0.4 ± 0.221
Scarus niger	0.17	2.50	0.434 ± 0.216	0.13	4.75	0.633 ± 0.387	0.83	3.00	0.25 ± 0.25	0.19	1.67	0.312 ± 0.176			
Acanthurus xanthopterus	0.87	1.50	0.13 ± 0.095	0.13	4.00	0.533 ± 0.313									
Chaetodon lunula	0.43	3.80	1.652 ± 0.56				0.83	2.00	0.166 ± 0.166	0.13	1.50	0.187 ± 0.135			
Chaetodon reticulatus	0.27	1.67	0.434 ± 0.175				0.42	1.60	0.666 ± 0.256	0.25	1.75	0.437 ± 0.203	0.40	1.50	0.6 ± 0.305
Scarus spinus	0.87	1.00	0.086 ± 0.06				0.25	1.00	0.25 ± 0.13	0.44	1.86	0.812 ± 0.305	0.10	1.00	0.1 ± 0.1

Appendix I (Part B, continued)

	East Reefs												South Reefs		
	Goofnuw (23)			Tomil (30)			Barge (12)			Peelaek (16)			South (10)		
Species	% obs	Enc. density	Overall density	% obs	Enc density	Overall density	% obs	Enc. density	Overall density	% obs	Enc. density	Overall density	% obs	Enc density	Overall density
Neoniphon argenteus				0.33	3.00	0.1 ± 0.1									
Hipposcarus longiceps				0.33	1.00	0.033 ± 0.033									
Parupeneus barberinoides							0.83	1.00	0.083 ± 0.083	0.13	1.00	0.125 ± 0.085	0.10	4.00	0.4 ± 0.4
Chaetodon kleinii	0.13	1.00	0.13 ± 0.071	0.27	1.25	0.333 ± 0.11									
Rhinecanthus aculeatus				0.27	1.50	0.4 ± 0.148									
Chaetodon vagabundus	0.13	1.00	0.13 ± 0.071				0.17	2.00	0.333 ± 0.224	0.63	1.00	0.062 ± 0.062	0.20	1.00	0.2 ± 0.133
Myripristis kuntee							0.83	9.00	0.75 ± 0.75				0.20	3.00	0.6 ± 0.4
Gnathodentex aurolineatus															
Chaetodon unimaculatus				0.33	6.00	0.2 ± 0.2							0.20	1.00	0.2 ± 0.133
Balistapus undulatus							0.25	1.00	0.25 ± 0.13	0.25	1.75	0.437 ± 0.223	0.20	1.50	0.3 ± 0.213
Rhinecanthus rectangulus				0.33	1.00	0.033 ± 0.033	0.17	2.00	0.333 ± 0.256	0.13	1.50	0.187 ± 0.135	0.20	1.00	0.2 ± 0.133
Chaetodon ulietensis	0.13	1.67	0.217 ± 0.125										0.10	2.00	0.2 ± 0.2
Epibulus insidiator	0.43	1.00	0.043 ± 0.043	0.13	1.50	0.2 ± 0.1	0.33	1.00	0.333 ± 0.142						
Cetoscarus bicolor	0.43	1.00	0.043 ± 0.043										0.10	1.00	0.1 ± 0.1
Caranx melampygus				0.33	1.00	0.033 ± 0.033							0.10	3.00	0.3 ± 0.3
Mulloidichthys flavolineatus	0.43	1.00	0.043 ± 0.043										0.10	1.00	0.1 ± 0.1
Myripristis violacea	0.87	2.50	0.217 ± 0.177	0.13	2.25	0.3 ± 0.152									
Forcipiger flavissimus										0.25	1.50	0.375 ± 0.179	0.30	1.33	0.4 ± 0.221
Chaetodon lineolatus															
Sargocentron spiniferum	0.43	1.00	0.043 ± 0.043	0.67	3.50	0.233 ± 0.201							0.10	1.00	0.1 ± 0.1
Chaetodon rafflesii	0.13	1.33	0.173 ± 0.102				0.83	2.00	0.166 ± 0.166	0.63	2.00	0.125 ± 0.125	0.10	2.00	0.2 ± 0.2
Lutjanus ehrenbergi	0.43	1.00	0.043 ± 0.043	0.67	1.00	0.066 ± 0.046									
Cheilinus trilobatus	0.43	1.00	0.043 ± 0.043				0.17	1.00	0.166 ± 0.112	0.25	1.00	0.25 ± 0.111			
Siganus puellus	0.87	1.00	0.086 ± 0.06	0.67	2.50	0.166 ± 0.136									
Parupeneus barberinus															
Parupeneus cyclostomus										0.63	4.00	0.25 ± 0.25			
Rhinecanthus verrucosa				0.13	1.00	0.133 ± 0.063				0.63	2.00	0.125 ± 0.125	0.20	2.00	0.4 ± 0.266
Epinephelus merra	0.43	1.00	0.043 ± 0.043										0.20	1.50	0.3 ± 0.213
Heniochus chrysostomus	0.13	1.00	0.13 ± 0.071	0.67	1.00	0.066 ± 0.046									
Scarus frenatus				0.33	1.00	0.033 ± 0.033	0.17	1.00	0.166 ± 0.112	0.19	1.33	0.25 ± 0.144	0.10	1.00	0.1 ± 0.1
Lutjanus bohar															
Plectorhinchus lineatus				0.33	1.00	0.033 ± 0.033									
Cephalopholis urodeta										0.25	1.00	0.25 ± 0.111	0.10	1.00	0.1 ± 0.1

Appendix I (Part B, continued)

	East Reefs												South Reefs		
	Goofnuw (23)			Tomil (30)			Barge (12)			Peelaek (16)			South (10)		
Species	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc. density**	**Overall density**	**% obs**	**Enc density**	**Overall density**
Scarus psittacus										0.63	3.00	0.187 ± 0.187			
Scarus globiceps	0.13	1.67	0.217 ± 0.125												
Cephalopholis argus							0.83	1.00	0.083 ± 0.083	0.63	1.00	0.062 ± 0.062	0.20	1.00	0.2 ± 0.133
Myripristis woodsi															
Sargocentron microstoma	0.43	1.00	0.043 ± 0.043												
Chlorurus microrhinos										0.63	1.00	0.062 ± 0.062			
Myripristis berndti	0.43	2.00	0.086 ± 0.086	0.33	3.00	0.1 ± 0.1									
Melichthys niger							0.83	1.00	0.083 ± 0.083	0.63	1.00	0.062 ± 0.062			
Lutjanus monostigma				0.33	1.00	0.033 ± 0.033									
Epinephelus melanostigmus	0.43	1.00	0.043 ± 0.043										0.20	1.50	0.3 ± 0.213
Chlorurus bleekeri	0.43	1.00	0.043 ± 0.043	0.33	1.00	0.033 ± 0.033	0.83	1.00	0.083 ± 0.083						
Lutjanus gibbus															
Lutjanus semicinctus															
Chaetodon baronessa	0.43	1.00	0.043 ± 0.043	0.67	1.50	0.1 ± 0.073									
Plectorhinchus vittatus															
Chlorurus frontalis				0.10	1.33	0.133 ± 0.079									
Lethrinus erythracanthus	0.43	1.00	0.043 ± 0.043	0.33	1.00	0.033 ± 0.033									

Appendix II. Mean densities (# • m^{-2}; all ± 1SE) of 144 fish species (ranked by abundance) encountered during stationary count surveys summed across all sites and by habitat. "Count" = number of surveys in which a species was encountered). Total number of surveys for each habitat category given in parentheses.

Species	All sites (57)		Back-reef (33)		Forereef (10)		Channel (14)	
	Count	Density	Count	Density	Count	Density	Count	Density
Ctenochaetus striatus	52	0.546 ± 0.07	28	0.305 ± 0.03	1	1.1 ± 0.171	14	0.759 ± 0.151
Thalassoma amblycephalum	21	0.542 ± 0.163	9	0.428 ± 0.087	9	1.094 ± 0.363	3	0.481 ± 0.121
Acanthurus triostegus	13	0.531 ± 0.252	1	0.56 ± 0.229	2	0.595 ± 0	1	2.547
Amblygliphidodon ternatensis	1	0.509	1	0.595				
Chromis viridis	20	0.48 ± 0.166	18	0.67 ± 0.182			2	0.136 ± 0.016
Acanthurus lineatus	10	0.428 ± 0.11			10	0.514 ± 0.111		
Stegastes nigricans	30	0.394 ± 0.07	22	0.519 ± 0.083	3	0.209 ± 0.028	5	0.622 ± 0.152
Chlorurus sordidus	47	0.388 ± 0.038	29	0.523 ± 0.072	6	0.531 ± 0.146	12	0.383 ± 0.062
Thalassoma quinquevittatum	7	0.371 ± 0.105			7	0.388 ± 0.103		
Dascyllus aruanus	21	0.361 ± 0.061	18	0.505 ± 0.059			3	0.357 ± 0.137
Stegastes lividus	7	0.298 ± 0.072	3	0.39 ± 0.148			4	0.391 ± 0.072
Amblygliphidodon curacao	23	0.292 ± 0.058	22	0.419 ± 0.08			1	0.595
Hemiglyphidodon plagiometopon	2	0.28 ± 0.229	2	0.595				
Scarus spp (juvenile)	14	0.28 ± 0.065	9	0.455 ± 0.071	3	0.39 ± 0.189	2	0.476 ± 0.119
Chrysiptera brownriggii	7	0.247 ± 0.061	1	0.357	6	0.252 ± 0.067		
Thalassoma purpureum	3	0.237 ± 0.111	1	0.119	2	0.305 ± 0.152		
Gnathodentex aurolineatus	2	0.229 ± 0.178	2	0.535 ± 0.059				
Scolopsis ciliata	27	0.219 ± 0.059	23	0.386 ± 0.066	2	0.595 ± 0	2	0.348 ± 0.11
Plectorhinchus lessoni	1	0.203	1	0.238				
Scarus ghobban	1	0.203			1	0.238		
Chrysiptera cyanea	6	0.199 ± 0.019	3	0.223 ± 0.023	1	0.152	2	0.203 ± 0.05
Plectroglyphidodon leucozonus	3	0.186 ± 0.067	2	0.254 ± 0			1	0.595
Thalassoma hardwicke	40	0.165 ± 0.029	28	0.34 ± 0.039	2	0.543 ± 0.424	1	0.348 ± 0.07
Naso lituratus	4	0.152 ± 0.058	3	0.368 ± 0.113	1	0.595		
Lutjanus bohar	1	0.152	1	0.152				
Chrysiptera biocellata	7	0.134 ± 0.046	6	0.439 ± 0.071	1	0.238		
Dischistodus melanotus	41	0.132 ± 0.013	28	0.259 ± 0.037			13	0.281 ± 0.053
Acanthurus guttatus	1	0.127	1	0.127				

Appendix II (continued)

Species	All sites (57)		Back-reef (33)		Forereef (10)		Channel (14)	
	Count	Density	Count	Density	Count	Density	Count	Density
Halichoeres trimaculatus	22	0.121 ± 0.022	14	0.448 ± 0.063			8	0.216 ± 0.061
Stegastes albifasciatus	8	0.121 ± 0.018	7	0.279 ± 0.083			1	0.152
Gnatholepis anjerensis	18	0.118 ± 0.019	14	0.372 ± 0.069	1	0.595	3	0.396 ± 0.105
Mulloidichthys flavolineatus	3	0.118 ± 0.016	3	0.13 ± 0.011				
Acanthurus nigricans	23	0.115 ± 0.017	14	0.459 ± 0.059	5	0.248 ± 0.004	4	0.365 ± 0.132
Chrysiptera traceyi	8	0.114 ± 0.015	2	0.374 ± 0.221	3	0.141 ± 0.011	3	0.289 ± 0.153
Chaetodon trifascialis	24	0.108 ± 0.016	11	0.414 ± 0.064			13	0.282 ± 0.054
Plectroglyphidodon lacrymatus	7	0.105 ± 0.025	6	0.252 ± 0.071			1	0.595
Myripristis berndti	18	0.103 ± 0.016	15	0.331 ± 0.051	1	0.595	2	0.357 ± 0.238
Atrosalarias fuscus	3	0.101 ± 0.05	3	0.476 ± 0.119				
Pseudocheilinus hexataenia	2	0.101 ± 0.05			1	0.152	1	0.595
Choerodon anchorago	3	0.101 ± 0.029	3	0.289 ± 0.153				
Labropsis micronesica	5	0.101 ± 0.022	3	0.3 ± 0.147	1	0.595	1	0.119
Cephalopholis urodeta	1	0.101			1	0.119		
Dischistodus chrysopoecilus	1	0.101			1	0.119		
Halichoeres melanurus	1	0.101	1	0.119				
Halichoeres pallidus	1	0.101	1	0.119				
Melichthys vidua	1	0.101			1	0.119		
Myripristis kuntee	1	0.101	1	0.119				
Scarus globiceps	1	0.101	1	0.119				
Thalassoma lunare	1	0.101	1	0.119				
Zebrasoma scopas	18	0.097 ± 0.014	12	0.385 ± 0.064			6	0.303 ± 0.094
Scarus oviceps	33	0.094 ± 0.015	18	0.431 ± 0.05	4	0.476 ± 0.119	11	0.317 ± 0.067
Chaetodon citrinellus	18	0.093 ± 0.011	5	0.309 ± 0.116	4	0.365 ± 0.132	9	0.293 ± 0.077
Neoniphon sammara	6	0.093 ± 0.008	3	0.119 ± 0			3	0.277 ± 0.158
Chaetodon lunulatus	22	0.088 ± 0.009	1	0.384 ± 0.072	2	0.595 ± 0	1	0.137 ± 0.012
Labroides dimidiatus	24	0.087 ± 0.009	17	0.372 ± 0.059	3	0.436 ± 0.158	4	0.374 ± 0.127
Acanthurus nigricauda	3	0.084 ± 0.033	2	0.595 ± 0			1	0.152
Chaetodon melannotus	6	0.084 ± 0.021					6	0.447 ± 0.093
Sphaeramia nematoptera	3	0.084 ± 0.016	3	0.277 ± 0.158				

Appendix II (continued)

Species	All sites (57)		Back-reef (33)		Forereef (10)		Channel (14)	
	Count	Density	Count	Density	Count	Density	Count	Density
Scarus dimidiatus	19	0.084 ± 0.013	1	0.32 ± 0.061	1	0.595	8	0.476 ± 0.077
Labrichthys unilineatus	8	0.082 ± 0.019			1	0.595	7	0.408 ± 0.089
Epibulus insidiator	12	0.08 ± 0.011	5	0.323 ± 0.111	1	0.595	6	0.436 ± 0.1
Corythoichthys intestinalis	18	0.079 ± 0.013	11	0.477 ± 0.061			7	0.362 ± 0.084
Chromis margaritifer	2	0.076 ± 0.025	1	0.595	1	0.119		
Chaetodon rafflesii	2	0.076 ± 0.025	1	0.595	1	0.119		
Chaetodon unimaculatus	2	0.076 ± 0.025			1	0.119	1	0.595
Halichoeres margaritaceus	6	0.076 ± 0.017	6	0.442 ± 0.096				
Epinephelus melanostigmus	4	0.076 ± 0.014	2	0.357 ± 0.238			2	0.357 ± 0.238
Hipposcarus longiceps	4	0.076 ± 0.014	4	0.357 ± 0.137				
Plectroglyphidodon dickii	4	0.076 ± 0.014			4	0.357 ± 0.137		
Chaetodon auriga	21	0.076 ± 0.011	18	0.389 ± 0.051	1	0.119	2	0.357 ± 0.238
Dischistodus perspicillatus	5	0.076 ± 0.011	5	0.438 ± 0.134				
Sargocentron microstoma	12	0.076 ± 0.011	9	0.391 ± 0.08	1	0.595	2	0.595 ± 0
Stethojulis bandanensis	10	0.073 ± 0.016	6	0.479 ± 0.073	3	0.436 ± 0.158	1	0.119
Balistapus undulatus	7	0.072 ± 0.015			4	0.484 ± 0.11	3	0.436 ± 0.158
Scolopsis trilineata	4	0.07 ± 0.028	2	0.425 ± 0.17			2	0.374 ± 0.221
Halichoeres hortulanus	17	0.07 ± 0.009	5	0.527 ± 0.068	7	0.464 ± 0.084	5	0.316 ± 0.114
Chaetodon ephippium	11	0.069 ± 0.007	4	0.357 ± 0.137	1	0.119	6	0.516 ± 0.079
Zanclus cornutus	19	0.069 ± 0.007	14	0.447 ± 0.056	1	0.119	4	0.238 ± 0.119
Melichthys niger	3	0.067 ± 0.016	3	0.436 ± 0.158				
Monotaxis grandoculis	3	0.067 ± 0.016	3	0.436 ± 0.158				
Blenniella chrysospilos	9	0.067 ± 0.012	3	0.595 ± 0	5	0.411 ± 0.112	1	0.595
Lethrinus harak	5	0.066 ± 0.022	4	0.399 ± 0.114			1	0.595
Caranx melampygus	8	0.066 ± 0.016	5	0.391 ± 0.083	1	0.152	2	0.119 ± 0
Cheilinus fasciatus	7	0.065 ± 0.009	2	0.357 ± 0.238	1	0.595	4	0.476 ± 0.119
Canthigaster valentini	6	0.063 ± 0.012	4	0.272 ± 0.112			2	0.595 ± 0
Chaetodon reticulatus	4	0.063 ± 0.012			2	0.595 ± 0	2	0.357 ± 0.238
Parupeneus cyclostomus	4	0.063 ± 0.012	2	0.595 ± 0	1	0.595	1	0.119
Zebrasoma veliferum	4	0.063 ± 0.012	2	0.595 ± 0			2	

Appendix II (continued)

Species	All sites (57)		Back-reef (33)		Forereef (10)		Channel (14)	
	Count	Density	Count	Density	Count	Density	Count	Density
Parupeneus multifasciatus	10	0.063 ± 0.01	7	0.556 ± 0.071	1	0.595	2	0.595 ± 0
Heniochus chrysostomus	12	0.063 ± 0.008	9	0.361 ± 0.076	2	0.357 ± 0.238	1	0.595
Coris gaimard	5	0.061 ± 0.01	3	0.436 ± 0.158			2	0.595 ± 0
Halichoeres marginatus	5	0.061 ± 0.01	2	0.595 ± 0	2	0.357 ± 0.238	1	0.595
Hemigymnus melapterus	14	0.06 ± 0.006	1	0.466 ± 0.066			4	0.476 ± 0.119
Chaetodon lunula	3	0.059 ± 0.022	2	0.425 ± 0.17			1	0.119
Gomphosus varius	14	0.058 ± 0.006	7	0.362 ± 0.085	6	0.516 ± 0.079	1	0.595
Chaetodon ulietensis	5	0.056 ± 0.012	3	0.481 ± 0.113			2	0.357 ± 0.238
Cheilinus undulatus	13	0.052 ± 0.008	11	0.462 ± 0.056	1	0.595	1	0.595
Canthigaster bennetti	6	0.05 ± 2.404	2	0.595 ± 0	2	0.595 ± 0	2	0.595 ± 0
Apogon novemfasciatus	2	0.05 ± 0	2	0.595 ± 0				
Aulostomus chinensis	4	0.05 ± 0	3	0.595 ± 0			1	0.595
Cephalopholis argus	2	0.05 ± 0			1	0.595	1	0.595
Cetoscarus bicolor	2	0.05 ± 0			2	0.595 ± 0		
Chaetodon kleinii	2	0.05 ± 0					2	0.595 ± 0
Chaetodon oxycephalus	2	0.05 ± 0					2	0.595 ± 0
Cheilodipterus quinquelineata	2	0.05 ± 0	2	0.595 ± 0				
Corythoichthys flavofasciatus	2	0.05 ± 0					2	0.595 ± 0
Dascyllus melanurus	3	0.05 ± 0	1	0.595			2	0.595 ± 0
Epinephelus hexagonatus	2	0.05 ± 0			2	0.595 ± 0		
Epinephelus merra	2	0.05 ± 0	1	0.595			1	0.595
Labroides bicolor	5	0.05 ± 0			1	0.595	4	0.595 ± 0
Parupeneus barberinoides	2	0.05 ± 0	1	0.595			1	0.595
Sargocentron spiniferum	2	0.05 ± 0	2	0.595 ± 0				
Siganus doliatus	3	0.05 ± 0	2	0.595 ± 0			1	0.595
Siganus puellus	2	0.05 ± 0	2	0.595 ± 0				
Anampses melanurus	1	0.05			1	0.595		
Aspidontus dussemieri	1	0.05	1	0.595				
Cephalopholis miniata	1	0.05			1	0.595		
Chaetodon baronessa	1	0.05	1	0.595				

Appendix II (continued)

Species	All sites (57)		Back-reef (33)		Forereef (10)		Channel (14)	
	Count	Density	Count	Density	Count	Density	Count	Density
Chlorurus bleekeri	1	0.05			1	0.595		
Chaetodon lineolatus	1	0.05	1	0.595				
Chaetodon meyeri	1	0.05					1	0.595
Cheilinus trilobatus	1	0.05	1	0.595				
Forcipiger flavissimus	1	0.05			1	0.595		
Gymnothorax javanicus	1	0.05	1	0.595				
Hemigymnus fasciatus	1	0.05			1	0.595		
Lutjanus ehrenbergi	1	0.05	1	0.595				
Lutjanus fulvus	1	0.05	1	0.595				
Lutjanus gibbus	1	0.05	1	0.595				
Neoglyphidodon melas	1	0.05	1	0.595				
Novaculicthys taeniourus	1	0.05					1	0.595
Ostracion meleagris	1	0.05	1	0.595				
Paracirrhites arcatus	1	0.05			1	0.595		
Parupeneus barberinus	1	0.05	1	0.595				
Pempheris otaitensis	1	0.05					1	0.595
Plectorhinchus lineatus	1	0.05	1	0.595				
Plagiotremus rhynorhynchus	1	0.05	1	0.595				
Plectorhinchus gibbosus	1	0.05					1	0.595
Pomacentrus vaiuli	1	0.05	1	0.595				
Rhinecanthus aculeatus	1	0.05			1	0.595		
Rhinecanthus verrucosa	1	0.05	1	0.595				
Scarus niger	1	0.05					1	0.595
Scarus spinus	1	0.05			1	0.595		
Stethojulis trilineata	1	0.05			1	0.595		
Chaetodon vagabundus	6	0.046 ± 0.004	3	0.481 ± 0.113	1	0.595	2	0.595 ± 0